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ABSTRACT

Title of Dissertation: SHAPING THE SOUND OF MUSIC: THE EVOLUTION OF THE PHONOGRAPH RECORD, 1877-1950

Alexander Boyden Magoun, Doctor of Philosophy, 2000

Dissertation directed by: Professor Robert Friedel
Department of History

Why do people try to improve things? The question is fundamental to the study of technology. This thesis uses the phonograph record to demonstrate the constructed nature of the human behaviors shaping the development of artifacts. It shows that within a market environment, itself constructed by participants, individuals acting alone and collectively developed different definitions of "better." Inventors sought technical solutions, entrepreneurs sought profits, and consumers sought ways to use their leisure time. Numerous factors affected their efforts in ways that defy modeling. Despite the conflicts between definitions and the contingency of the process, the study suggests that participants improved the sound of the record.

This study traces the construction of the technology, its markets, and

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certain consumer tastes, from invention to the acceptance of the longplaying record (LP) by the Radio Corporation of America (RCA). The process involved incremental as well as revolutionary change based on a presumptive anomaly, none of which was determined by purely technological, commercial, or consumer considerations.

The narrative begins with the constructed novelty of Thomas Edison's tin foil cylinder. Alexander Bell's group innovated a wax cylinder for stenography; when consumers rejected it, producers adapted the record for entertainment. Simultaneously, Emile Berliner invented a disc intended to revolutionize mass production. Eldridge Johnson formed the Victor Talking Machine Company to establish the 78-rpm disc as the dominant format into the 1950s.

Given the competition of radio in the 1920s, Victor accepted AT&T's revolutionary recording and reproduction techniques. RCA bought Victor and sought improvements consumers would accept during the Depression. When consumers responded, they rejected sound reproduction described as "high fidelity." RCA's engineers responded with a low-fidelity 45-rpm record whose innovation was delayed by war and a boom market. Columbia Records introduced the LP in 1948. Despite improvements to the 45's sound, RCA could not overcome consumer definitions of fidelity favoring the LP, and accepted the format in 1950.

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SHAPING THE SOUND OF MUSIC: THE EVOLUTION OF THE PHONOGRAPH RECORD, 1877-1950

by

Alexander Boyden Magoun

Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2000

Advisory Committee:
Dr. Robert Friedel, Chair
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Because of the journeys I have taken en route to completing this dissertation, there are more people to thank than is usual.

A procession of graduate advisors in the Department of History at the University of Maryland, College Park--Drs. Ronald Hoffman, J. R. Cockburn, Brigitte Bedos-Rezak, James Henretta, and Kenneth Holum--has put up with and pushed me on the path to completion of the degree. Dr. Jon Sumida graciously accepted my change in fields and provided a valuable perspective on the nature of scholarship. Dr. Richard Price led me through my major field exams and assured me at one point that I had "it," which was more reassuring than he imagined or probably remembers.

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This dissertation started and finished, however, under my advisor, Dr. Robert Friedel. When I told him I wanted to study phonograph records and needed a problem, Robert raised the question, obvious to him, of why the sound of recordings improved. The next six years comprised portions of suggestions, criticism, patience, browbeating, and encouragement on his part, all in the right measure. In the last few weeks, he has performed the remarkable of successfully balancing my sanity with persuading me of the possibilities inherent in my research. No one could ask for a better mentor. That his words seemed to have little effect on my progress is a reflection on me, not him; I will always regret that I took too long in most cases to act on his always excellent advice.

No end of gratitude goes to Dr. Pamela Henson, historian at the Smithsonian Institution Archives. In December 1993, I had thrown up my hands at the prospect of embarking on the dissertation. She pulled me back from the precipice and encouraged me to press on. It was all up hill or down hill from there, depending on your choice of metaphors.

To the powers that were and be at the Society of History of Technology (SHOT), I feel grateful for the existence of this community of scholars. The annual meetings have been opportunities to compare notes with scholars at all stages of research and careers, give and receive moral support, and deliver papers. I am especially honored by receipt of the

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Melvin Kranzberg Dissertation Fellowship for 1998, and hope that this thesis justifies some of the confidence shown in me.

Periodically I produced a draft or a paper, and various individual gave of their time and comments. To Dr. Hans-Joachim Braun of the University of Hamburg I am obliged for his ongoing symposium at the International Commitee on the History of Technology (ICOHTEC) conferences on Technology and Music. I gave a paper on the origins of the 45-rpm record at the Budapest meeting in 1996, and I thank the anonymous referee who prodded me to clarify my thinking before Hans added it to a forthcoming volume. I also benefitted from comments on a revised version of that paper at the SHOT meeting in Detroit in 1999. Dr. Hillel Schwartz pushed me to engage more of the cultural consequences of technological change, which I fear I have neglected here. I am also indebted to my Department and the Graduate School, who thought enough of my project at an early stage for helping underwrite that trip through the Hearst Travel Grant program, and to SHOT's Dibner Fund for helping underwrite presentation of a version of Chapter Four at the ICOHTEC meeting in Belfort, France, in 1999.

Among many colleagues in the history of technology community, I am indebted to Dr. Jonathan Coopersmith and Dr. Pamela Laird for their encouragement over the years. Dr. Emily Thompson very kindly gave me a copy of her dissertation when I needed to know what a great dissertation in a related topic looked like. Dr. Mark Clark also provided a copy of his

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dissertation on the development of magnetic recording and the sort of encouragement that only makes sense to one who has been through the experience. Harvey Cohen, Gary Frost, and Sue Horning have proved to be wonderful sources, sounding boards, hosts, and friends in the course of our parallel efforts to understand the complexity of change in sound recording and reproduction.

Having gained Robert's assent to supervising my dissertation, I took a leave of absence that brought me quite by chance to Philadelphia. I have coach Charles Torpey of LaSalle University to thank for the location. It was entirely coincidental that this move put me in perhaps the best possible position for researching the phonograph record. Thanks to the generous fellowship program of the Hagley Museum and Library in Wilmington, Delaware, I spent a month going through their RCA collection. With the gracious assistance of Anne Horsey, I spent a couple of days at the Eldridge Johnson Victrola Museum in Dover, Delaware. Going through Mr. Johnson's papers and comparing the sound of a Victrola, an Orthophonic Victrola, and an Electrola also proved invaluable for understanding the man behind the talking machine and the sounds he embraced and resisted.

In the other direction lay the holdings of RCA's laboratories in Princeton. These include more than the papers of David Sarnoff in the library bearing his name. Under the auspices of Alice Archer and the late M. Phyllis Smith at what is now Sarnoff Corporation, and with the help of the

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excellent librarians, Larry Eubank and Victor Santapau, I also gained complete access to files of the RCA Laboratories that helped me understand the philosophy and practice of innovation under David Sarnoff. Perhaps equally important was having the run of the library's serials of every technical journal for amateurs and professionals I could desire, as well as various RCA publications and serials, and best of all, free photocopying. My research there led to my current position as curator for Sarnoff Corporation, which has provided me with continued access to these collections on- and off-duty, as well as access to the growing number of websites on the recording industry. I thank executive vice-president Susan Gauff, People and Communications, and Dr. Thomas Lento, director, Market Communications, for their support and encouragement.

Phyllis and Alice, through their vast RCA connections, also put me in touch with various retirees. Many of those in the Delaware Valley belong to the RCA/GE/Martin Marietta Luncheon Club. Through Harry Young, secretary, I was able to make a plea for assistance to 246 assembled diners in 1994. I wish I could have spoken with all of them, for they constitute a treasury of the history of electronics innovation in the mid-twentieth century. Instead, I had the fortune to hear from Murlan S. Corrington, Dana Hall, George Singer, Michael Ranalli, the late Tony DeNicola, Phil Wooley, and Nicholas F. Pensiero. Mr. Pensiero made available his collection of RCA/Victor materials, now deposited at the Hagley. Foremost in his

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assistance has been Charles Hobbs, who has shared his recollections and analyses, technical and organizational, of the corporation as a whole and its record and phonograph divisions in particular. His helpfulness knows no bounds, extending to his gift of a 45-rpm record player, which he obtained and restored, all the while documenting the latter process in one of many carefully composed letters.

Other retirees include J. Guy Woodward and Herbert Belar of Harry Olson's Acoustics Lab group. Dr. Woodward answered my callow questions with thoughtful responses, while Mr. Belar offered his recollections of R&D in sound recording in the 1930s and 1940s. Warren Rex Isom is a former chief engineer of the Record Division. His postgraduate training consists of two degrees in Government, and he graciously and wittily answered my questions about the record innovation. He also gave me several out-of-print histories of the phonograph, and provided further contacts with retirees in the Hoosier state. These include Marshall Whitehurst and Carl Martin, who donated his file on the stuffs of which records were made during and after World War II.

In Indianapolis, I had an opportunity through the assistance of Thomson/RCA's public affairs office and librarian Susan Hall, to visit the Thomson History Center. This contains documentation of virtually every product manufactured by RCA Consumer Electronics, RCA Victor Home Instruments, as well as the first 45-rpm record.

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Returning to New Jersey, I also visited the Camden County Historical Society, where Paul Schopp made available their impressive RCA advertising collection and run of Voice of the Victor. Carl Gainsborough pointed me to the vertical files on Victor Talking Machine Company and RCA at the Camden Public Library. When the city repairs the crack in the wall of the building, I and the residents will be able to visit the second floor, where the stacks and vertical files are located.

I have lived in nicer neighborhoods than Olney and Tacony, Philadelphia, but the city's library resources have few rivals. Starting with Holy Family College, where I served as archivist, I thank Sister Mary Francesca Onley, president; Kathy Mulroy, former director of library services; and the remarkable staff in the library for providing an excellent place to work and study. Florence Hogan obtained for me obscure books and articles through interlibrary loan that had nothing to do with the college's curriculum; Florence Dolan helped keep me sane. Jim Raiss and Colette Hutton, formerly of the Audio-Visual department, encouraged me to use their facilities, and with Jim's great good help and offers of meals, I did. Kathy got the library on-line not a moment too late since the internet connection, even with an 1,800-bit modem, kept me in touch with Robert, David, and members of SHOT and ICOHTEC. Small Catholic colleges are often caretakers of unexpected treasures; in this case, it was a complete, indexed run of Fortune magazine; the post-1945 volumes of the Saturday

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Review of Literature; and the Atlantic Monthly. Again, free photocopying for articles and columns was a boon.

I also had the honor of borrowing privileges and access to the microfilm resources of LaSalle's Donnelly library, and of free run through the stacks of the University of Pennsylvania's Van Pelt and Communications Libraries. I am indebted to LaSalle's archivist Brother Joe Grabenstein, C.B., for hosting a meeting between me and an RCA retiree. The Free Library of Philadelphia, Tacony branch, and the main branch's Music Division gave me access to bibliographies and books I would not have otherwise known about.

While in Chappaqua, New York, I had opportunity and reason to draw on the holdings of Chappaqua Public Library and visit the Rockefeller Archives, in Valhalla, New York. Similarly, in Princeton, I have benefited from borrowing privileges at the Princeton Public Library as well as Princeton University's Firestone and Music Libraries, courtesy of Sarnoff Corporation's borrowing card. I also made several visits to the Oral History Office and Special Collections branch of Columbia University's libraries. Mary Marjorie Clark, director of the Oral History Project, made available the transcript of the voluminous oral history she conducted with Dr. Frank Stanton, former president of CBS. Dr. Stanton also kindly responded to my follow-up questions.

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When I returned to College Park, I tapped my own university's libraries--McKeldin, Hornbake, Engineering and Physical Sciences, and Performing Arts--for their serial holdings, patent, and interlibrary loan resources. Not to be left out is the Library of American Broadcasting, on-campus repository of the Broadcast Pioneers Library, among many other collections. Michael Henry, archivist extraordinaire, made sense of otherwise obscure finding aids and inventories, and let me photocopy my way through the serials High Fidelity and RCA's The Scanner. I also benefitted from access to files at the National Archives II. Contacts there led me to the Washington, D.C., facility, and from there to the United States Court of Appeals for the Federal Circuit, Washington, D.C. I spent much time at the Library of Congress, where the card catalog remains a resource to respect, and where the Sound Recordings library proved helpful.

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At my prospectus defense, Dr. Gilbert asked, "Where is the music?" I believe I have given it its place in a study of improving the sound of the record, and in the process of writing, I have benefitted from musical accompaniment by the following performers: Jon Anderson, Duke Ellington, Peter Gabriel, Gilbert and Sullivan, Phillip Glass, Jah Wobble's Invaders of the Heart, Kraftwerk, Annie Lennox, Gordon Lightfoot, the Moody Blues, Willie Nelson, Lee "Scratch" Perry, Madeline Peyroux, R.E.M., Roxy Music, Simon and Garfinkel, Dusty Springfield, Arturo Toscanini, Barry White, and the film soundtracks for Brazil, Cabaret, Music Man, My Fair Lady, South Pacific, and Trainspotting.

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"Shaping the Sound of Music: The Evolution of the Phonograph Record, 1877-1950"

Introduction

In 1877 Thomas Edison recorded and then reproduced his voice on a strip of waxed paper run under a stylus glued to a diaphragm. In the words of his chief assistant, it was not "fine talking, but the shape of it was there."[1] Seventy-five years later, the record industry used automatic machinery to produce millions of grooved plastic discs invented by corporate teams of electrical and mechanical engineers, chemists, physicists, executives, marketers, and consumers during the 1940s. For the rest of the century, millions of consumers listened to these records at home, in jukeboxes, and through their radios. The diffusion of turntables on which to play records, which had never exceeded fifty percent of American households in the first seventy-five years of the technology, reached saturation by 1975. The use of the records called LPs and 45s stimulated growth within an already mature industry such that sales nearly matched film exhibition grosses by the end of the 1960s. The LP became the subject of further innovation in efforts to add more information to the groove cut and traced by a stylus. Finally, records became the core of the American experience of music in all of its varieties, as well as a variety of musical, commercial, and technical subcultures,

---

[1]"Charles Batchelor's Recollections of Edison: No. 1 The Invention of the Phonograph," in The Papers of Thomas A. Edison, ed. Reese V. Jenkins, vol. 3, Menlo Park: The Early Tears, April 1876-December 1877, ed. Robert A. Rosenberg et al. (Baltimore: 1994), Appendix 2, 699-700.

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including one promoting the pursuit of "high fidelity." LPs remained the standard for home sound reproduction until the diffusion of compact discs (CDs) in the 1990s. Even then, some listeners insisted that the best analog recordings surpassed CDs in sound quality.

The persistence of analog recordings in the face of digital technologies, the success of high fidelity, and the diffusion of recorded sound in the twentieth century all make the study of record innovation important and intriguing. We lack an explanation, however, for why the record assumed the shapes it did for the second half of the twentieth century. We might begin by examining the origins of the records themselves. Why did the LP and 45 become the standard formats in 1950? Why not earlier or later? In particular, why did the LP become the design on which later innovations in sound reproduction capability were based?

This study describes the evolution of the record as a process of individuals constructing technologies, markets, and cultures of sound reproduction that determined the LP's success. The record evolved artificially, constructed by three groups interested in its development. Inventors comprised the mechanics, engineers, recordists, chemists, and physicists, among others, who created knowledge, technique, and technology. Entrepreneurs included investors, manufacturers, executives, marketers, advertisers, distributors, and dealers. These were the middlemen who made and sold the products rendered from the inventors' work.

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Consumers included those who bought and, as importantly, used the records for entertainment, enlightenment, or their sound quality. They also included the performers who decided whether they wanted to associate themselves with the quality of reproduction in return for a larger, "invisible" audience.[2]

Each group had subgroups, and members sometimes wore two or more hats. An inventor could be an entrepreneur or a member of a corporate staff of engineers, an engineer could be a consumer, and a dealer could be a entrepreneur and consumer, often simultaneously. They interacted outside and within the market environment that constitutes the basis for any exchange of resources. The nature of their encounters ranged from random to planned. Tracing the evolution of the record from the late nineteenth century to the middle of the twentieth offers an opportunity to see the similarities in behavior surrounding innovation, entrepreneurship, and consumption, despite the tremendous changes in the structures of these activities.

These groups acted, reacted, and negotiated based on rationales constructed from their assumptions, beliefs, and experiences about the nature of improvement. They interacted to create and recreate the record, its market, and the culture in which the record evolved. Each enjoyed a

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[2]See Russell Lynes, The Lively Audience: A Social History of the Visual and Performing Arts in America, 1890-1950 (New York: 1985), 43-44.

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particular means of influence: the power to create, produce and sell, or buy the technology, based in part on the rise and fall in demand for records. Each had concealed within them multiple rationales for a choice of action at any point of decision. What was one to create or, more frequently, improve? Under what assumptions, limitations, or definitions did the inventor operate? How was an entrepreneur to make and sell the improvement? What was the market and where among competing entrepreneurs did one fit? Finally, what choices did the consumer have? Why buy records, and why buy one record or one format over another?

Sound was only one of the characteristics valued by the participants. Its refinement took place within an enviroment filled with niches where cost, durability, storage density, or playing time were more important for success. Participants had to establish which was most important for the survival or expansion of their place in the markets for records. Sound on disc itself is composed of several variables: the range of reproducible frequencies and tones, loudness, noise or the sounds added to the recorded performance, and the ratio between noise and the performance. These too had their niches, leading to more conflict among proponents for each as well as conflict with advocates for the other variables.

Not surprisingly, those involved found it difficult to agree on the meaning of "better." Inventors who solved problems inside the black box or demonstrated an improvement in principle were less concerned with its

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application in practice. Entrepreneurs who marketed one record format found themselves alienated from consumers of other formats. Consumers who bought and listened to records for different uses--for entertainment, status, aesthetic edification, or sound--differed with each other as well as inventor and entrepreneur. The LP represented one possible outcome in 1950 based on the decisions of individuals and representatives of various groups ranging back over seventy-five years. Each chapter describes the decisions that ultimately resulted in the ascension of the LP, and also raises the question of what constitutes improvement for a technology.

What is technological improvement? A comparison of formats from different eras that demonstrates the superiority of one over another ignores the systemic changes necessary to enjoy the improvements. No one in 1900 had the control of electrical power, the manmade thermoplastics, the production capacity to manufacture one-mil styli--much less the research techniques and facilities necessary to develop them--that made first electrical recording and then "high fidelity" possible twenty-five and fifty years later. We may also grant that Edison's celluloid cylinders offered greater fidelity than Victor 78s, or that a 45-rpm record sounded less distorted than an LP, even as we note that consumers preferred the record with more inherent technical flaws for sound reproduction.

Nonetheless, the improvement over time exists, as anyone who has compared nineteenth-century records with those made more recently can

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attest. Improvement is also observable within shorter frames of time or within the same technology. The inventor, entrepreneur, and consumer could all hear the difference in sound between acoustic and "Orthophonic" reproduction in 1925 even though nothing had changed in the appearance of the record, the type of stylus, or in the power source to drive the phonograph.

We cannot assign cause simply to progressive technological development, in which each generation of inventors builds on the accomplishments of the last to make ever "better" records. We need to know why the inventors took the directions they did in developing the record, and the factors that affected their definition of improvement. We cannot assume that competition or patent control determined the marketing strategies of the entrepreneur. We need to know the nature of the competition--for market or market share--the place of patents within or outside the industry, and whether the strategy depended on improvement in price, technology, performer content, or some combination thereof. Finally, we cannot assume that a faceless mass of consumers determined the direction, pace, and scope of change in the shape and sound of the record. We need to know which consumers took an interest in the format and sound, as opposed to the musical content, how they defined a better record, and how they organized their influence on those providing the technology.

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Traditional interpretations overlook this greater, constructed nature of the process of innovation. Improvement should not be regarded as a story of technological momentum, the outcome of invisible market forces or visible hands, or consumer seduction and manipulation. These interpretations suggest a certain determinacy to the outcome. In the first case, one system has gained such support in the process from other systems of production and consumption that it proves impossible to dislodge.[3] In the second, the end product is always the best result for all involved because the profit motive has given everyone what he or she wanted in that product.[4] In the third, groups within the entrepreneurial realm, supported by other members of society's elites, collaborate to induce the public to buy the unnecessary products of a modern capitalist economy.[5]

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[3]Thomas Hughes makes the case for momentum as it might apply in an industrial market in Networks of Power: Electrification in Western Society (Baltimore: 1983), and "The Evolution of Large Technological Systems," in Wiebe E. Bijker, Hughes, and Trevor Pinch, eds., The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology (Cambridge, Mass.: 1987), 51-82.

[4]Richard Tedlow's New and Improved: The Story of Mass Marketing in America (New York: 1990) provides an example of this argument with a series of case studies. As such it follows implicitly the benign portrait of American corporations and their products as described by Alfred D. Chandler, Jr., in The Visible Hand: The Managerial Revolution in American Business (Cambridge, Mass.: 1977), among his other works.

[5]See William Leach, Land of Desire: Merchants, Power, and the Rise of a New American Culture (New York: 1993), and Jackson Lears, Fables of Abundance: A Cultural History of Advertising in America (New York: 1994), for the most persuasive syntheses in support of this argument.

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Instead, the LP emerged out of negotiations and decisions by participants where the consequences ranged from long-term to immediate in effect. These run back to the invention of the record itself and the search for markets; to the transitions in materials and shape of the record itself; to the decisions to electrify the process of generating sound and organize consumption of classical music; to the efforts to define and market "high fidelity" in the 1930s; to changes in corporate strategy and structure; to the timing and evaluation of innovation. Behind each of these choices stood individuals acting on their backgrounds, motivations, talents, experiences, and personalities, all while seeking their own form of improvement: in solving a technical problem, making a profit, or using leisure time.

This study leaves us with the conundrum of improvement arising out of the contingent, constructed mixture of human interaction with the natural and manmade environments.[6] In a capitalist culture valuing change through value added to the raw materials of human creativity and natural resources, it is inevitable that in some cases people should succeed in improving the technologies they adopt and use. The point is not entirely teleological in nature. The narrative should make clear that but for a few changes in personality and events, cylinders or 45s could have been the

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[6]See John M. Staudenmaier, "Rationality versus Contingency in the History of Technology," in Merritt Roe Smith and Leo Marx, eds., Does Technology Drive History? The Dilemma of Technological Determinism (Cambridge, Mass.: 1994), 260-71.

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high-fidelity medium of choice. In any outcome, however, over time, participants will improve the capabilities of the technology, whatever shape it assumes.[7]

The story of the record represents a particularly useful example of the constructed nature of the material world because of the ability of the participants to reinvent the record in different ways for different purposes.[8] In a field where most studies of change focus on the emergence of a technology or a paradigmatic shift, the role of patents in corporate innovation, or the relationship between innovation and corporate strategy, this study goes further in also examining the negotiations in and out of the marketplace between inventors, entrepreneurs, and consumers.[9] As such, it

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[7]See Edward W. Constant II, "Reliable Knowledge and Unreliable Stuff: On the Practical Role of Rational Beliefs," Technology & Culture 40, no. 2 (April 1999), 324-357, for the most thoughtful argument against a relativistic attitude in the history of technology.

[8]As a study of the construction of the phonograph record over seventy-three years in which there are three revolutions in the technology, its subject does not align easily with any of the themes noted in the articles of Technology & Culture by John M. Staudenmaier in Technology's Storytellers: Reweaving the Human Fabric (Cambridge, Mass.: 1983).

[9]For examples of the emergence of a technology, see Robert Friedel, Pioneer Plastic: The Making and Selling of Celluloid (Madison, Wis.: 1983); idem, Zipper: An Exploration in Novelty (New York: 1994); for a new paradigm, see Edwin W. Constant, Jr., The Origins of the Turbojet Revolution (Baltimore: 1980); for the relationship between innovation and strategy, see Reese V. Jenkins, Images and Enterprise: Technology and the American Photographic Industry, 1839 to 1925 (Baltimore: 1975) and Paul Israel, From Machine Shop to Industrial Laboratory: Telegraphy, 1830-1920 (Baltimore: 1992); for the role of patents see W. Rupert MacLaurin, with R.

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may be seen as an extension of Hugh Aitken and Susan Douglas's work on the construction of radio by scientist, inventor, entrepreneur, and listener alike.[10]

There are three aspects to the evolution of the record that make its history particularly remarkable. Two of them involve the entrepreneur and the consumer. First, the largely oligopolistic nature of the record industry by entrepreneurs controlling patents or market share makes innovation somewhat unexpected. It is sometimes assumed that in a system where patents enable control of a technology, those holding the patents limit the amount of innovation to the detriment of the consumer as well as the inventor. More revolutionary change, presumably representing improvement, could have taken place, to the benefit of users, in a more open innovative environment. Why did entrepreneurs decide to make radical changes? Second, there is the overwhelming interest by consumers in the content the record provides rather than the record itself. They bought records to hear music, not sound: high fidelity was and remains a low priority for listeners desiring a background, a beat, or a tune. If we assume,

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Joyce Harman, Invention and Innovation in the Radio Industry (New York: 1949); and Leonard Reich, The Making of American Research: Science and Business at GE and Bell, 1876-1926 (New York: 1985).

[10]Hugh G. J. Aitken, Syntony and Spark: The Origins of Radio (New York: 1976); idem, The Continuous Wave: Technology and American Radio, 1900-1932 (Princeton, N.J.: 1985); Susan J. Douglas, Inventing American Broadcasting, 1899-1922 (Baltimore: 1987); idem, Listening In: Radio and the American Imagination (New York: 1999).

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as the larger record companies have, that most consumers will not pay a premium for better sound, how did they successfully innovate formats offering that improvement?

This narrative shows that patents were only one component of commercial strategy and behavior. While the existence of patents sometimes limited innovation, their presence or the prospect of profit from them also inspired change in the record and its capabilities. The power of market share also stimulated an attempt to impose a patented revolutionary innovation on the rest of the industry and consumers. Similarly, music and price were only two of several factors consumers weighed in making purchases. The type of music available on a format, the status gained from ownership of a particular performer or sound, and the relative convenience of a format also played roles in the consumers' improvement of the record. The story of the record's evolution reveals a variety of other sources of technological delay, redirection, and innovation, including inventive traditions, the egos of the entrepreneurs and corporate executives, the aesthetic interests of consumers, and national emergencies.

The third aspect involves the nature of invention itself. The process of change resulting from these negotiations between groups was incremental but punctuated by revolutionary developments. The revolutions took place approximately every generation, in which inventors changed the format, from cylinder to disc record; technique, from acoustic to

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electro-acoustic; and the combination of the two seen in the playing time and fidelity enabled by microgrooves and mathematics. The first represented in part an effort to invent around basic patents, the second constituted a licensed innovation from outside the industry, and the third was based partly on the prospect of patent licensing. They appear to fit the model of Constant's presumptive anomaly, but as we shall see, the process of successful innovation in each comprises much more than a battle of new and old technological paradigms.[11]

An attempt to understand technological change from multiple perspectives on both sides of Ruth Schwartz Cowan's "consumption junction" must necessarily be limited. Cowan proposed that the success or failure of an innovation can be understood by looking at the new product from the perspective and context of the consumer.[12] This study tries to explain the direction of the record by examining it from the contexts of the inventor, entrepreneur, and consumer. The prejudices of the writer are reflected in the use of evidence most convenient for the subject. Substantial

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[11]For the compressed and extended versions of the model surrounding this concept, see Edward W. Constant II, "A Model for Technological Change Applied to the Turbojet Revolution," Technology & Culture 14, no. 4 (October 1973), 553-72, and idem, The Origins of the Turbojet Revolution (Baltimore: 1980).

[12]Ruth Schwartz Cowan, "The Consumption Junction: A Proposal for Research Strategies in the Sociology of Technology," in Wiebe E. Bijker, Thomas P. Hughes, and Trevor Pinch, eds., The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology (Cambridge, Mass.: 1987), 261-80.

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bodies of material survive the first two groups and help explain the actions of individuals within them. Consumers are more difficult to locate, particularly for the acoustic era, but certain techniques and increasing amounts of documentation over time indicate the way some groups of consumers in particular influenced the record's development.

The consumers highlighted in the second half of the thesis are the classical music lovers whose records are most discussed in the best standard history. In the 1920s, this group began to construct an influential culture, leaving behind magazines filled with their commentary on the state of record technology and classical music and the relationship between them. The orchestral music that they listened to best challenged the capabilities of the record, in frequency and dynamic ranges and in playing time. This was the music that engineers used to test the quality of new recordings and that record companies sought in order to add prestige and value to their labels. The popular music of this period, which comprised the vast bulk of recordings, was never as complex, which is not surprising given the purposes for which it was composed and consumed.

The limitations are unfortunate because the history of sound recording and reproduction has received little attention from scholars. In appeal, it lacks the history and impact of print media, the visual appeal of photography and motion pictures, or the broadcast power of radio and

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television.[13] Music historians are only just beginning to explore the context beyond the texts they have traditionally analyzed.[14] The standard histories that do not suffer from factual flaws have been written by amateur historians, some with axes to grind.[15] Edison has enjoyed special attention in large part because of the enormous archive he left behind.[16]

Recently, however, scholars have examined the relationships between recording and musicians on the one hand, and phonograph music

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[13]Steven Lubar's InfoCulture: The Smithsonian Book of Information Age Inventions (New York: 1993), is the rare history that compares the phonograph with other media.

[14]For an example of the new music history that includes some references to the means of production and reproduction, see Robert P. Morgan, ed., Modern Times: From World War I to the Present, Music and Society Series ed. Stanley Sadie (Englewood Cliffs, N.J.: 1993).

[15]Andre Millard's America on Record: A History of Recorded Sound (New York: 1995) is the only academic survey and it suffers from numerous errors. Oliver Read and Walter L. Welch's From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed., (Indianapolis: 1976; 1st ed., 1959) provides a bibliography but represents an extreme example of Edison cultism. Welch collaborated with Leah Burt on a revision covering the acoustic era, From Tin Foil to Stereo: The Acoustic Years of the Recording Industry (Gainesville, Fla.: 1994). This edition leavens the emphasis on Edison but contains more errors. Roland Gelatt's The Fabulous Phonograph: From Edison to Stereo, 3d ed., (New York: 1977) remains the best general history. It appeared originally as a series of articles in High Fidelity in 1954 and 1955 before publication of the first and second editions in 1955 and 1965.

[16]See especially Paul Israel, Edison: A Life of Invention, (New York: 1998); also Emily Thompson, "Machines, Music, and Quest for Fidelity: Marketing the Edison Phonograph in America, 1877-1925" The Musical Quarterly 79, no. 1 (Spring 1995), 131-71. Use Andre Millard, Edison and the Business of Innovation (Baltimore: 1990), with care.

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and its listeners on the other.[17] Other studies of the technology have focused on other formats or smaller companies less committed to technological innovation or more committed to musical innovation.[18] There is also a fine study of the interplay between technology and audiophile culture as it played out near the end of the twentieth century.[19] As the treatment of the musical cultures surrounding the technology

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[17]For musicians, see John Harvith and Susan Edward Harvith. Edison, Musicians, and the Phonograph: A Century in Retrospect, (Westport, Conn.: 1987), and James P. Kraft, Stage to Studio: Musicians and the Sound Revolution, 1890-1950 (Baltimore: 1996). For the listener, see Simon Frith, Sound Effects: Youth, Leisure, the Politics of Rock 'n' Roll, (New York: 1981); Frith and Andrew Goodwin, eds., On Record: Rock, Pop, and the Written Word. (New York: 1990); and for a thorough analysis of the relationship of the record to American culture, see William Howland Kenney, Recorded Music in American Life: The Phonograph in Popular Memory, 1900-1945, (New York: 1999). See also Mark Katz, "The Phonograph Effect: The Influence of Recording on Listener, Performer, Composer, 1900-1940." (Ph.D. diss., University of Michigan, 1999), which Dr. Katz is revising for publication by the University of California Press.

[18]See Donald J. Mabry, "The Rise and Fall of Ace Records: A Case Study in the Independent Record Business," Business History Review 64 (Autumn 1990), 411-50; Rick Kennedy and Steve Allen, Jelly Roll, Bix, and Hoagy: gennett Studios and the Birth of Recorded Jazz (Bloomington, Ind.: 1994); Rick Kennedy and Randy McNutt, Little Labels, Big Sound: Small Record Companies and the Rise of American Music (Bloomington, Ind.: 1999); and David Morton, Off the Record: The Technology and Culture of Sound Recording in America (New Brunswick, N.J.: 2000). A scholarly study of the relationship between jazz record labels and jazz consumers has yet to be written, but the consumers formed a group similar to the classical music lovers described here.

[19]Joseph O'Connell, "The Fine-Tuning of a Golden Ear: High-End Audio and the Evolutionary Model of Technology," Technology & Culture 33, no. 1 (January 1992), 1-37.

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becomes more contextualized, it is hoped that that this study of the record will provide those historians with a more solid explanation of the technology's evolution.[20]

The choice of a narrative does not reflect an interest in developing a master history. Instead, it reflects the writer's prejudices in studying the process of cause and effect. We can acknowledge the fact that the stimulus for innovation and the process of determining successful innovation takes place through the mechanism of a market. We can acknowledge the stimulus of a capitalist culture that values novelty and improvement in the service of increasing wealth. We can acknowledge broader trends--increases in the skill and sophistication with which inventors carry out their creative duties, in the scale of industrial integration by entrepreneurs, in the increasing diversification of consumers. We can recognize the impact of events external to the industry, like the development of electronic technologies, the Depression, and World War II. Within these frameworks, however, we should focus on individuals in the process of innovation, inventors, entrepreneurs, and consumers who acted on motivations not easily catalogued in a model of technological change.

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[20]For examples of the new musical genre histories, see David W. Stowe, Swing Changes: Big-Band Jazz in New Deal America (Cambridge, Mass.: 1994); Lewis A. Erenburg, Swingin' the Dream: Bid Band Jazz and the Rebirth of American Culture (Chicago: 1998); and Nicholas Dawidoff, In the Land of Country: People and Places in American Music (New York: 1997).

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Part I: The Social Constuction of the Acoustic Phonograph, 1877-1924

On January 25, 1924, Raymond Sooy of the Victor Talking Machine Company made a series of phonograph recordings in Camden, New Jersey, with the Ted Weems Orchestra. This took place in the "Recording Laboratory" or "recording studio" on the seventh floor of Building #15.[1] Ten days earlier, Victor's Artist and Repertoire Committee had mandated an attempt to put two songs on one side of a twelve-inch disc that rotated at seventy-eight revolutions per minute. Sooy accomplished this by halving the pitch of the lead screw that moved the recording stylus radially across the wax-composition recording blank to fifty turns per inch. As the orchestra played, he cut one spiral groove in the spinning wax. Then, as it played a second song, he cut another spiral between the grooves of the first.[2]

In the studio, the bandmembers directed the sounds of their instruments into horns that channeled the sound waves to a diaphragm. This membrane was linked perpendicularly to the stylus so that the

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[1]Sooy used the terms "laboratory" and "studio" interchangeably; the company used the former as late as 1930: see Catalog of Victor Records for 1930 (Camden, N.J.: [1930]), [3], courtesy of Mr. Lawrence Stires.

[2]Raymond Sooy, "Memoirs of My Recording and Traveling Experiences for the Victor Talking Machine Company," entry for January 15, 1924, photocopy of unpublished typescript, courtesy Nicholas F. Pensiero. Mr. Pensiero was a marketing executive at RCA who obtained the typescript. An RCA corporate vice-president borrowed the original from him and never returned it. Mr. Pensiero's copy has been deposited with the Hagley Museum and Library as part of Collection 2138, "Files of Nicholas F. Pensiero."

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spiralled to the center of the disc. A weighted rope, attached to the turntable spindle, dropped down a six-story shaft and gave the turntable on which the record rotated a more constant speed than any spring-driven or electric motor.

Once recorded, the wax master was taken to the real laboratory, where workers electroplated the disc. A series of chemical baths layered various metallic coatings on the wax, which a worker then pulled apart, creating a metal master and a nickel-plated stamper. The stamper then went to the factory floor where an operator mounted it and another stamper in the two shelves of his press. Piped hot water warmed the stampers while the operator placed paper labels and a rectangular biscuit of shellac, powdered minerals, and carbon black in the center. He pressed the plates together, melting the biscuit into the grooves of the stampers, before running cool water through the pipes to harden the record. On removing the disc, he trimmed the "flash" overrun around the edges for recycling and stacked the record on a spindle for packaging and shipping.

Victor's marketing arm sent the Weems and other records to its national system of distributors, who relayed them to licensed dealers. Clerks stored the discs by the dozens in shelves behind a counter, and customers asked for a testplaying on one of the store's phonographs. If it met with approval, the clerk put it in a generic kraft paper sleeve which featured one-color promotions of Victor recording stars or the Victor sound. The

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customer paid between seventy-five cents for a ten-inch popular recording and up to five dollars for twelve-inch operatic discs.[3]

At home he or she could store the record in its sleeve or put it in an album, similar to those for scrapbooks or photographs, that could hold up to ten or twelve records. To play one, the consumer opened the top of a wooden-cased phonograph, either floorstanding or table-top, and centered the record on the spindle. Then he or she cranked the spring-driven motor and cued the needle or stylus, made of tungsten, steel, or bamboo depending on one's tonal preferences, in the lead-in groove on the record's rim.[4] The rounded 2.7 mil tip of the stylus, concentrating a force of about six ounces

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[3]Between 1908 and 1919 Victor charged $7.00 for "Chi mi frena," the sextette from Donizetti's Lucia di Lammermoor, performed by stars of the Metropolitan and Manhattan Opera Companies (Victor #96200). Another rendition featuring Enrico Caruso, released in 1912 (Victor #96201), also cost $7.00. A series of price cuts on single-sided Red Seal records reduced the price by more than half, but the twenty-five percent royalty paid to Francesco Tamagno for his ten-inch singles (Victor #95001-11) and to Adelina Patti for her twelve-inch records (Victor #95029-42) forced the company to maintain the five-dollar retail price. Records by Caruso, on the the other hand, could be had for a dollar: Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, rev. ed. (New York: 1965), 148-49; Michael W. Sherman, The Collector's Guide to Victor Records (Dallas: 1992), 58-60, 94-97.

[4]Victor owner Eldridge Johnson switched from a hard steel to a tungsten alloy in 1916 when the U. S. government placed the former on the restricted list for war production. The company and its successors continued to sell "Tungs-tone" styli until the 1930s, when it could consistently manufacture sapphire points: B. L. Aldridge, The Victor Talking Machine Company, ed. Frederic Bayh (Camden, New Jersey: 1964), 74-75; E. R. Fenimore Johnson, His Master's Voice was Eldridge R. Johnson (Milford, Del: 1974), 102.

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onto the walls of the groove, tracked the tracing of the soundwaves represented by the groove. In a reversal of the recording process, the stylus amplified the vibrations through a link to the center of a mica diaphragm. The movement of the diaphragm transduced the wave motion into sound, which was amplified through the expanding cross-section of the hollow tone arm into a horn built into the body of the phonograph or exposed above it. With a "Victrola" and its enclosed horn, the consumer could control the volume by adjusting shutters on the front of the phonograph. Three to five minutes later, the consumer returned to the machine to play the second song or another record and rewind the machine, unless he or she had a more expensive multiple-spring motor. Those who valued the sound quality also replaced the abraded stylus as Victor recommended after each record. As the tip became shaped to the groove, the mass of the sound box and tonearm concentrated on the bottom of the groove and wore away at it.

This entire process, from recording to consumption, had not changed significantly since Eldridge Reeves Johnson formed the Victor Talking Machine Company in 1901. Mr. Sooy started working in the recording lab in 1903. He relied on record blanks, diaphragms, and horns developed empirically, through cut-and-try experiment confirmed by what one heard. Vocalists had to modulate their voices or be manipulated by the recording staff so as not to "blast" the recording stylus through the groove wall in the

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wax disc into the adjoining grooves.[5] Sooy and conductors rearranged orchestras so that higher frequency instruments could be directed straight into the recording horn; some instruments, notably the violin, had to be modified to be used at all.[6] No one mistook the performance for a live concert. The record offered its own sound, underlined by the "scratch" of friction between steel needle and the mineral grains in the disc. Successful sales depended, therefore, less on promotion of the fidelity of reproduction than on the variety of recordings or the celebrity of the performers.

The formula pursued by Johnson and the Victor Talking Machine Company generated millions of dollars for him and other investors in the privately held company for nearly twenty-five years. Yet nothing in this description resembled Edison's invention of 1877, apart from the basic technique of recording and reproducing from a groove replicating the soundwave. From 1877, some fifteen years passed before other men began profiting from records as a form of home entertainment. Another fifteen years passed before Johnson established the pre-eminence of Emile

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[5]See the following interviews in John Harvith and Susan Edwards Harvith, Edison, Musicians, and the Phonograph: A Century in Retrospect, Contributions to the Study of Music and Dance, no. 11 (Westport, Conn.: 1987): Lotte Lehmann, 71; Rosa Ponselle, 80-81; Arthur Judson, 89.

[6]J. M. Augustus Stroh applied in 1899 for U. S. Patent 644,695, issued in 1900, on a metal violin with a fixed horn to direct the sound for recording purposes: Allen Koenigsberg, ed., The Patent History of the Phonograph, 1877-1912 (Brooklyn: 1990), lxii.

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Berliner's disc over Edison's cylinder. Fifteen more and radio emerged as a competition for the domestic ear. How was it that Johnson's predecessors and competitors, starting with Edison, overlooked what appeared in retrospect to be the obvious application?

The first three chapters explain why and how the phonograph record took so long to make its way into American homes, and how people improved it and its sound. Before one could conceive of an LP or its high fidelity sound, people had to invent the technology. Then they had to persuade others to invest in the creation of a use for it. They in turn had to persuade even more people to join in a market from which inventors, entrepreneurs, and consumers could negotiate further innovations. These processes took place over the first forty-five years of the record's existence. All of this required conscious choices on the part of participants. Individuals decided that this technology was more interesting than others to work on and improve, that it promised more profit than other products, and that it fulfilled more wants, needs, and desires than current alternatives.

The participants are recognizable by what they did, rather than by the contexts in which they acted. Inventors arose from a pre-modern culture of practical experimentation with chemicals and spring-powered mechanisms, and they made records of wax, rubber, insect resin, mineral dust, and the first manmade plastics. Entrepreneurs arose out of the proprietary culture

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of small businesses, for the record business was small for its first twenty-five years. When the entrepreneurs and consumers found a rapport in the market for home entertainment, the small businesses got bigger, but remained in the control of their founders. The consumers were public novelty seekers, male stenographers, frequenters of urban amusement halls, and a middle class of increasing affluence even as it remained tied to nineteenth-century entertainment media.

At the beginning and the end of this period, these people found it difficult to imagine the future of the record and capabilities, and impossible to predict it. Yet they were responsible for turning the record from a wax paper strip to a mass medium, a disc on which, for a dollar or less, one could hear almost anything for which someone thought there was a paying audience. The limits by the end of the era--in expense, brittleness, bulk, playing time, fidelity, scale of recorded ensembles, and number of companies offering records--seemed small in comparison to its origins, and determined only by the participants' contingent unpredictable cooperation in shaping the record and its sound to their mutual satisfaction.

The fact that the inventor himself abandoned his favorite invention at least twice indicates that there was nothing simple about its application to home entertainment. Edison, like other inventors, producers, and consumers, did not invest in the phonograph record in a vacuum. The uniqueness of the invention depended on its instantaneous ability to

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reproduce what it had recorded; there already existed many machines that reproduced music. These devices proliferated in the United States at the end of the nineteenth century in variety and number while they dropped in price. The record's evolution depended therefore as much on the efforts of people supporting other technologies and practices as it did on the predilections and patents of its backers, the limits and capabilities of the technology at any moment, and the desire for profit. To say that these groups improved it for market reasons begs questions of intention: which improvement, which market, which sales approach?

Edison, Berliner, and Johnson, among many others, made the phonograph record a viable home technology. To find and exploit that market, they had to come to terms with prejudices that affected their technological and commercial choices. Their understanding of consumer needs and desires turned the phonograph record from a novel phenomenon into an item used in millions of households in the first quarter of the twentieth century. Once established in a seller's market, however, that structure for home entertainment that proved difficult to modify until other inventors, entrepreneurs, and consumers developed another, electronic, system as a competitor. Consumer response to radio, and the radio companies' interest in technological and commercial links with the entrepreneurial leaders in home entertainment, remade the record

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and the participants in its evolution. The origins and consequences of that renaissance are the subject of the second part of the study.

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Chapter 1: Thomas Edison and the Novelty of the Phonograph, 1877-1878

Section I: Introduction

While various efforts had been made to record sound, or to reproduce the notes produced by keyboard instruments, no one had developed a device that recorded and reproduced the same sound until Thomas Edison did so in July 1877. Yet the components of the phonograph had existed for centuries, and mechano-acoustic analogies at least from the use of the lathe, leading some writers to suggest that it could have been invented some twenty to one hundred years earlier.[7] Invention involves not only material ingredients and their rearrangement into a new and productive configuration, but also a desire by the inventor to solve a problem or fill a perceived need. It is that incentive that stimulates one to novel rearrangment of familiar materials and techniques.

In Edison's case, the conception and development of the phonograph was an unintentional offshoot of his commercial and technical interests at the time. These interests shaped and limited his exploitation of sound reproduction technically and commercially. The tin foil record was useful for demonstrating the possibilities of the principle, but little more. Consumers paid once to hear the phenomenon of reproduced speech and

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[7]Warren Rex Isom, "A Wonderful Invention But Not a Breakthrough...," Journal of the Audio Engineering Society 25, no. 10/11, (October/November 1977): 657; Robert J. Weber, Forks, Phonographs, and Hot Air Balloons: A Field Guide to Inventive Thinking (New York: 1992), 150-54.

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did not return to hear it again. In the year following its invention, Edison became caught up in the many possible applications of sound reproduction, his sudden celebrity, and other events before moving on to the electric light system.[8] He left the phonograph to his inventive and entrepreneurial rivals to innovate as something more than a novelty.

Section II: Invention, July-October 1877

In 1877, Edison was thirty years old and respected for his inventive ablilities within the telegraph industry. He had renewed a contract with the Western Union Telegraph Company to design around and improve on Alexander Bell's new telephone as well as to continue research on means of increasing the density of telegraph transmissions on existing lines. Edison thus concentrated the efforts of his research team on sound transmitters and data recorders between the summer of 1876 and the spring of 1878.[9] In the early summer of 1877, when he first carried out experiments on sound recording and reproduction, Edison was blending research and development

[8]See Paul Israel, Edison: A Life of Invention (New York: 1998), 152-64. I wrote Chapters 1-3 before consulting it; significant additions will be noted.

[9]The Papers of Thomas A. Edison, ed. Reese V. Jenkins, vol. 3, Menlo Park: The Early Years, April 1876-December 1877, ed. Robert A. Rosenberg et al. (Baltimore, 1994), 63-64 (hereafter cited as EP).

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in three areas that overlapped in a systemic spectrum from telegraphy to telephony.[10]

First, Edison was developing a repeating telegraph recorder built for fast transmission of messages and more leisurely transcription by operators. This approach was not new for Edison, for his first invention in 1865 was a telegraphic recorder/reproducer.[11] Between the fall of 1876 and spring of 1877 Edison had developed a recorder and contracted to build six of them for Western Union. This machine resembled a disc phonograph record player, for it used a turntable with styli pivoting on an arm from a post mounted outside the rotating plate. These styli embossed an incoming message on heavy paper fixed over a spiral groove in the plate. Edison continued to tinker with the design, and early in July 1877 proposed treating the paper

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[10]Matthew Josephson, Edison: A Biography (New York: 1959), 159; Michael J. Biel, "The Making and Use of Recordings in Broadcasting before 1936" (Ph.D. diss., Northwestern University, 1977), 60-67; Raymond R. Wile, "The Edison Invention of the Phonograph," ARSC Journal 14, 2 (1983): 9; Paul Israel, "Telegraphy and Edison's Invention Factory," in William S. Pretzer, ed., Working at Inventing: Thomas A. Edison and the Menlo Park Experience (Dearborn, Michigan: 1989), 73. Robert Conot in his biograhy, A Streak of Luck: The Life and Legend of Thomas Alva Edison (New York: 1979), 97-99, 101, argues for four inventive challenges leading to the phonograph, including the electromotograph because of his experimentation with cylinders.

[11]EP, 249, n. 3.

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with "any oleagenous substance" [sic] to stiffen it, like parafin, or embossing directly onto a thin "metallic foil."[12]

Second, Edison worked on the telephone transmitter. He attempted to improve Bell's system by increasing the correlation between sound waves hitting a diaphragm and the variation in electrical resistance generated on the other side. During 1877 he and his group researched the best components for this part of a "speaking telegraph." The prime problem, noted in the lab and by Edison's publicist at the Centennial Exhibition in Philadelphia, was not the "quantity" of sound in transmission, but that the "quality of tone" needed improvement.[13] Moreover, the transmitter was inconsistent; every voice required adjustment of the diaphragm and its linkages.[14]

In particular Edison and his assistant Charles Batchelor struggled with the transmission of soft consonants: "th," "ch," "sh," "s," "and other hissing sounds." Assuming that the sounds were "composed of vibrations and are

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[12]EP, 147; 202; 249, n. 2; also, doc. 806, "6Notebook Entry: Telegraph Recorder/Repeater," October 28, 1876, pp. 161-3; doc. 809, "Notebook Entry: Telegraph Recorder/Repeater," November 2, 1876, p. 168; doc. 857, "Production Model: Telegraph Recorder/Repeater," [February 3, 1877?], pp. 248-50; doc. 955, "Technical Note: Autographic Telegraphy and Telegraph Recorder/Repeater," pp. 419-20.

[13]EP, doc. 950, "From Edward Johnson," June 29, 1877, pp. 408-409; doc. 967, "From Edward Johnson," July 17, 1877, pp. 435-37; 974, pp. 452-53.

[14]EP, doc. 953, "From Edward Johnson," July 5, 1877, pp. 415-16.

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notes having an exceedingly low rate of vibration" of about ten per second, Edison suggested either adjusting the length of the speaking tube to reinforce the frequency or adding a second tube for their emphasis.[15] Despite early optimism about resolution of the sibilant problem, problems persisted, and the staff carried out endless component adjustments and tests of carbon compounds for the transducer behind the diaphragm.[16]

Finally, Edison began considering the technical implications of the commercial relationship between the telephone and telegraph. The major flaw of the telephone was its inability to record its messages, according to those in the telegraph industry who assumed "the public must delegate to corporate bodies the carrying" of electric communications. Edison accepted this assumption. Twice he envisioned a keyboard with each letter wired to the appropriate vibrations and overtones to produce speech which would be printed out at the other end of the line. The point is not that Edison's conception further limited the impact of speech transmission, but that he

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[15]EP, doc. 921, "Technical Note: Telephony," May 26, 1877, p. 359.

[16]EP, doc. 932, "Notebook Entry: Telephony," June 6, 1877, pp. 379-80; doc. 939, "Technical Note: Telephony," June 17, 1877, p. 393; doc. 941, "Technical Note: Telephony," June 18, 1877, pp. 395-6; doc. 944, "Technical Note: Telephony," June 26, 1877, pp. 399-400; doc. 948, "Technical Note: Telephony," June 27, 1877, pp. 405-407.

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was thinking about the transduction of sound waves, from one medium to another, and back again.[17]

This led to further efforts to condense telephone messages on-line. Early on Tuesday morning, July 17, after a long night's work, Edison proposed a recorder to resolve this perceived bottleneck, where speech could be reproduced "slow or fast by a copyist & written down." Likening the application to recording and reproducing telegraphy at different speeds, he scribbled a bird's-eye-view of a "revolving plate" with "two telephone tubes," one for recording, the other for reproduction. These were held by arms that met at a post outside the plate and moved in an arc from center to rim or vice versa. Edison had invented a phonograph system, but it was several hours before he realized the implications of what he had conceived, and tried to make it work.[18]

On July 18, Edison resumed work on the consonants "hissing" from Bell's telephone.[19] This occupied Edison and his team until they stopped for

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[17]Quote from Edward H. Johnson, Telephone Hand Book (New York: 1877), 10, cited in EP, 441; also doc. 921, "Technical Note: Telephony," May 26, 1877, pp. 360-61; doc. 964, "Technical Note: Telephony," July 11, 1877, pp. 430-31.

[18]EP, 411-12, and doc. 969, "Technical Note: Telephony," July 17, 1877, pp. 440-41.

[19]EP, doc. 972, "Technical Note: Telephony and Phonograph," July 18, 1877, pp. 443-44.

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their midnight supper. He was still mulling the quality of the experimental diaphragms after the meal, feeling the movement of the various diaphragms and their contact points with his finger as he intoned into the rubber mouthpieces. At that point he turned to his chief assistant, Charles Batchelor, and proposed that a point on the diaphragm could indent, "make a record of," the vibrations on a moving piece of material, which would play back when the point was retraced along the groove. Batchelor got up to find a needle point, as well as some of the "old automatic telegraph paper" which was coated with paraffin and a grooved telegraph board. Machinist John Kruesi assembled the components so that the strip of paper could be pulled over the groove and under the diaphragm and stylus. They were ready in an hour, whereupon Edison sat down and spoke one of their telephone test sentences, "Mary had a little lamb," into the mouthpiece while Batchelor pulled the strip. All could see the markings and on resetting the device and pulling the groove through again "we got "ary ad elll am.' It was not "fine talking, but the shape of it was there and so like the talking that we all let out a yell of satisfaction and a 'Golly it's there'!! and shook hands all round."[20]

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[20]"Charles Batchelor's Recollections of Edison: No. 1 The Invention of the Phonograph," in EP, Appendix 2, 699-700. A marginally different transcription is reprinted in Appendix I of Walter L. Welch, Charles Batchelor: Edison's Chief Partner (Syracuse, New York: 1972), 107-108. Most accounts of the first phonographic experiment rely on Edison's recollections, despite the many flaws in his memory and the self-serving nature of the interviews he gave: see Conot, 461-64.

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It was probably during this celebration, in the wee hours of Thursday, July 19, that Edison wrote about the experiment. The quality of the indentations left "no doubt" in Edison's mind "that I shall be able to store up & reproduce automatically . . . the human voice perfectly."[21] The group then abandoned the telephone and spent the rest of the night adjusting the depth of the point and testing variations of the format.[22] Later that day, Edison modified a provisional specification for the British patent of his telephone system, noting that adapted components of his system could now be used "to make a record of the atmospheric sound waves."[23]

With this experiment, Edison not only made a conceptual breakthrough but put it into practice. It is the combination that makes him the inventor of sound recording and reproduction. Others had developed devices for one technique or the other. Leon Scott de Martinville had recorded sound in 1857 on his "phonautograph," a device still in use for scientific analysis of sound twenty years later.[24] Englishman Joseph B. Fenby patented an "Electro Magnetic Phonograph" in 1863 where inputs to a

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[21]EP, doc. 972, "Technical Note: Telephony and Phonograph," pp. 443-44, quotes on 444.

[22]Ibid., p. 445, n. 4.

[23]EP, doc. 973, "British Provisional Patent Specification: Telephony and Phonograph," pp. 446-47, 449, nn. 1, 5.

[24]Biel, 48-50.

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keyboard would be punched in a paper tape and then reproduced.[25] Those precedents explain why Edison's lawyers titled his patent only "Improvements on Phonograph or Speaking Machines," although they cited no prior patents. Finally, unlike the French poet Charles Cros, who effectively described phonography and the production of record copies in April 1877, Edison made his conception work.[26]

This development was peripheral to the contracted problem of improving on Bell's telephone, however, and Edison focused on the issue of phonographic perfection only sporadically until December. But what did perfection in sound reproduction mean in 1877? For Edison, that depended on which technology he was working on, its stage of development, and its intended purpose. If transcribing clerks were going to use the phonograph, Edison needed to settle on a final form for production, determine a useful playing time, and ensure the recording and reproduction of distinct

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[25]British Patent 101, January 13, 1863; Isom, "A Wonderful Invention," 657; Koenigsberg, vii.

[26]Lacking funds for a patent, Cros deposited at the Académie des Sciences in Paris a sealed paper written on April 18, 1877, in which he described a phonograph where soundwave tracings on a disc could be photoengraved and mass-produced for reproduction: Gelatt, 23-24. The paper, "Procédé D'enregistrement et de Reproduction des Phénomènes Perçus par L'ouïe" is in Charles Cros, Oeuvres Complètes, ed. Louis Forestier and Pascal Pia (Paris: 1964), 523-24. Cros applied for and received in mid-1878 French Patent 124,213 for his conception: Koenigsberg, vii; Raymond R. Wile, "Etching the Human Voice: The Berliner Invention of the Gramophone," ARSC Journal 21, no. 1 (Spring 1990): 19 n. 18.

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articulation. In general, these requirements would be accomplished by running some recording material at a constant speed past the stylus during recording and reproduction. They also required constant contact of the stylus to the surface, with indentations made relative to the intensity and frequency of the soundwaves vibrating the diaphragm. Edison had outlined separate recording and reproduction heads, the former using a heavier stylus to impress the waxed paper, the latter being of lighter design so as not to destroy the groove.[27] Loudness, durability, and extraneous noise were less important because the recording was intended for a clerk in an office, who would play back the recording once in order to transcribe or relay it locally. The term "phonograph" also reflected Edison's commercial assumptions, for it had been associated with office shorthand techniques since the 1830s.[28]

The definition of improvement in the phonograph lay in sharp contrast to those of the telephone. There existed in telephony competitive and commercial pressures to make a product as loud, clear, and compact as Bell's, and one that could transmit the sound input effectively over long

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[27]EP, doc. 969, "Technical Note: Telephony," July 17, 1877, p. 441; doc. 1004, "Technical Note: Phonograph and Telephony," August 12, 1877, p. 494.

[28]Oxford English Dictionary, 2d ed., s.v. "phonography." Joseph B. Fenby patented in 1863 a "phonograph" which described the principles of the player piano. Edison named his invention on August 12, in his first follow-up to the conception in July: EP, doc. 1004, "Technical Note: Phonograph and Telephony," p. 494.

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distances. Nonetheless, Edison was well aware of the patent imbroglio that would arise from competing telephone innovators, and saw the phonographic aspect of the communications system as a unique asset and therefore valuable to his patron, Western Union. Technically, it was hardly far behind the more touted device. Edward Johnson, Edison's publicist, reported on the successful reception of the telephone in Philadelphia and at summer resorts, where the wealthy clientele represented some of the first prospective users. Its "immense success," after all of the work at Menlo Park, rested on the "great novelty" of the receipt in Saratoga, New York, of "distinguishable words" from Manhattan.[29]

Section III: Innovation, September-December 1877

While spending most of his time on the telephone, then, Edison continued to develop the phonograph as a complementary product of sound reproduction, making improvements within the framework of its background and future application. In specifying "rapid" speech and tinkering with embossed paper strips, Edison assumed that the phonograph was a means of accelerating telegraphed transmissions. It eliminated one step in telegraphy because the message would not have to be translated into code. The sender would talk into the telephone and have the speech recorded at the other end, where it could be played back more slowly for

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[29]EP, doc. 991, "From Edward Johnson," August 4, 1877, pp. 481-82; doc. 1027, "From Edward Johnson," August 30, 1877, p. 520.

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transcription. In September Edison drafted a promotional article on recording "automatically the speech of a very rapid speaker upon paper" and then reproducing it "immediately or year's [sic] afterwards."[30] He persisted with embossing or indenting paper strips despite occasional forays into tin foil or disc formats.[31]

The emphasis on "rapid" speech also reflected Edison's attempts to turn technical liabilities into assets. Already Edison claimed in private that his deafness was an advantage in evaluating sound quality. In the lab he reported that the articulation in his telephone--not the phonograph--had become "so perfect that. . . . [t]he strain on the ears appears to have departed at least in my case."[32] On the other hand, he had not yet convinced his prospective customers, apologizing to one for a delay and explaining he was "so deaf that I am debarred from hearing all the finer articulations & have to depend on the judgment of others."[33]

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[30]EP, doc. 1039, "Draft Article: Phonograph," September 7, 1877, pp. 533-34; doc. 1040, "Technical Note: Phonograph," September 7, 1877, 535.

[31]EP, doc. 1013, "Technical Note: Phonograph and Telephony," August 17, 1877, pp. 502-503. See also "Batchelor's Recollections," in EP, 700; "Charles Batchelor," in Welch, 108.

[32]EP, doc. 1022, "To Thomas David," August 27, 1877, p. 516.

[33]EP, doc. 1025, "To Thomas David," August 29, 1877, p. 518; see also Israel, 153.

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As for technical drawbacks, faster speech meant less articulation as sounds slurred together, and a relatively shorter recording. This became a necessity since Edison had not devised a means to increase playing time significantly. Waxed paper strips could not be practically stored after recording. This limitation led during the fall to the phonograph's transformation from a medium for the transmission of lengthy congressional speeches by wire to an office dictation device. In the first week of November, Edison changed the record format from waxed paper ribbon to tin foil glued by shellac around a grooved cylinder. With this change he concluded that he had the "easiest" method for phonography. Using a foot-long cylinder and a pitch of ten grooves to the inch, Edison could indent "about 200 words."[34] He also had a record loud enough to be heard without eartubes in a public space. In this transition from a strip of paper infinitely long to a finite cylinder Edison made the phonograph an independent system, with a potential for applications unrelated to the communications technologies from which it arose.

While he made these conceptual transitions, Edward Johnson reported Edison's latest invention to the Scientific American on November 17. Johnson's revelation of what Edison had yet to build stemmed from

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[34]EP, doc. 1099, "Technical Note: Phonograph," November 1, 1877, p. 613; quotes from doc. 1101, "Technical Note: Telephony and Phonograph," November 5, 1877, p. 615; doc. 1109, "Technical Note: Telephony and Phonograph," November 10, 1877, p. 622; R. Wile, "Edison," 15.

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publicity about other sound-recording devices. Unaware of Edison's switch to the cylinder, Johnson emphasized the versatility of Edison's tape system and its application in wired communications, which the editor endorsed. Again, the public claims for the quality of sound were modest, but Johnson, like Edison, assured the public that the phonograph would be "in practical operation within a year."[35]

Johnson forecast that the future of the phonograph lay in transferring speech records by wire, picking up on Edison's allusion to putting a telephone in the Senate chamber, and recording and redistributing speeches to editorial offices in New York.[36] The editor went further in a headnote, presuming the interests of his middle-class audience by focusing on high cultural and historical applications. He foresaw the prospect of hearing "the familiar voices of the dead." The advent of the phonograph threw into doubt the need for writing letters, and portended a new type of book in which "the orations of our modern Ciceros" could be repeated as desired.

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[35]EP, doc. 1102, "Edward Johnson to the editor of the Scientific American," November 6[?], 1877, pp. 615-7, and n. 1. Johnson's letter is also reprinted in Read and Welch, 13-14.

[36]Ibid. Johnson's reference to the "actual design" of the phonograph, p. 616, most likely refers not to the cylinder but to a different arrangement of the tape-recording and reproduction components, as in doc. 1099, p. 613.

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Finally, there was the prospect of music, but it was that of opera and oratorio "sung by the greatest living vocalists," not folk songs or music hall ditties.[37]

This revelation led not only to considerable comment in the New York newspapers, but it also helped Edison break temporarily from considering the phonograph as a strictly commercial tool. Writing on November 23, Edison began to see profit in the phonograph's place as a mundane fixture for the home. The phonograph could be a toy, added to dolls, animal figures, and steam engines. He imagined the reproduction of "sheet music both orchestral instrumental and vocal." He speculated on the device's use as a telephone answering machine, but then returned to "toys or apparatus in which only reproduction is required."[38]

Early on Edison recognized the possibility and profitability of mass reproduction of the original recording. For all of his devotion to invention for business and industry, he was well aware of the potential for consumption by the middle class. But Edison must have also recognized that western culture was awash in reproduced sound in the nineteenth century. Devices ranging from music boxes to barrel organs and steam calliopes filled small spaces and city squares with tunes and airs. All used a

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[37]"A Wonderful Invention--Speech Capable of Indefinite Repetition from Automatic Records," Scientific American, November 17, 1877, reprinted in Read and Welch, 11-12.

[38]R. Wile, "Edison," 15; EP, doc. 1119, "Technical Note: Phonograph," November 23, 1877, p. 629.

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cylinder pinned or studded, by hand, in order to strike a tuned array of tines or pipes to generate music. Not without a great deal of work could the phonograph be made to rival the products of decades of technical traditions. Entrepreneurs over the next thirteen years would instead exploit Edison's machine for its unique features even as the music machine makers developed new formats and lowered costs.[39] One was the ability to reproduce a recorded sound immediately on playback, and entrepreneurs recognized rightly and early on that people accepted home recording only for its novelty. The second was that which the Scientific American prized, the recording of the human voice. Yet here too Edison could have had no illusions about aspiring to the editors' aesthetic standards with a crude prototype whose operation required considerable practice and skill to elicit a recorded sound with any distinction.

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[39]The study of non-phonographic music machines remains dominated by dedicated collectors, and therefore isolated from other histories of technology, much less the purview of cultural, business, or social historians. See the relevant portions of Q. David Bowers, Put Another Nickel In: A History of Coin-Operated Pianos and Orchestrions (NY: 1966); idem, Encyclopedia of Automatic Musical Instruments (Vestal, NY: 1972); and Harvey Roehl, Keys to a Musical Past. . . (Vestal, NY: 1968). Cynthia Hoover, Music Machines American Style: A Catalog of the Exhibition (Washington, D. C.: 1971) and Steven Lubar, InfoCulture: The Smithsonian Book of Information Age Inventions (Boston: 1993), 174-75, acknowledge the relationship between music machines and phonograph technologies but do not explore it in any depth. Lawrence Levine, in High Brow/Low Brow: The Emergence of Cultural Hierarchy in America (Cambridge, MA: 1988), , emphasizes just how noisy pre-industrial urban society was, but focuses on street singers and musicians.

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Instead, for its inventor, the phonograph in 1877-78 was a means for the promotion of Edison's image as a genius, which in turn would fuel investment in his business of research. Like the telephone that Johnson had promoted on his behalf, the phonograph had to project something that music machines had not yet accomplished, the human voice, and do so before as large a paying audience as possible. To that end, Edison focused on loudness in the record at the expense of clarity or ease of mass production of copies.

Johnson's article also forced Edison to develop a practical prototype. Edison had not developed a spring motor that could drive the cylinder at a consistent speed against the resistance of the stylus indenting the foil, and it was impossible to crank the cylinder by hand at the same speed for more than a few seconds in recording and reproduction. Within a week, Edison finally committed to a shorter, fatter cylinder and tin foil for a "Trans[lating] Imbosser," and sketched two views, from which Kruesi spent six days making a working model. The prototype was ready on December 6. After betting his machinist a box of cigars that the device would work, Edison fitted a sheet of heavy tin foil around the grooved cylinder, cued the recording stylus, and while cranking the cylinder shouted again the first line of "Mary had a little lamb" into the receiving diaphragm. On finishing, the group returned the cylinder to its starting point, cued the speaking diaphragm and cranked the tin foil groove under the lighter stylus. Out

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came Edison's voice, much to the inventor's surprise; he was "always afraid of things that worked the first time."[40]

Section IV: Consumption, December 1877-November 1878

Edison, Batchelor, and Johnson took the phonograph to the offices of the Scientific American in New York on December 7, where it asked the listeners, "How do you do?" Despite the brevity of the recording--only one sentence--the reproduction elevated Edison's work above others who had only recorded sound.[41] It also led to more speculation on potential applications, which need to be evaluated in the context of the initial response to the performance of the phonograph. For the question arose almost immediately: what was it?

In public and private, men described the phonograph as a "wonderful invention." Benjamin Butler, former congressman and lawyer for the Atlantic and Pacific Telegraph Company, described the phonograph in

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[40]EP, 649; doc. 1133, "Technical Note: Phonograph," Novmber 29, 1877, p. 648; doc. 1137, "Technical Note: Phonograph," December 3, 1877, p. 652; doc. 1147, "Edward Johnson to Uriah Painter," December 8, 1877, 666; Edison quoted in Read and Welch, 18; Josephson, 163; Conot, 106-107.

[41]EP, doc. 1140, "Notebook Entry: Phonograph," December 4, 1877, 657, and doc. 1144, "Charles Batchelor to the Editor of the English Mechanic," December 7, 1877, 661, indicate that in tests of the prototype Edison and Batchelor obtained no more than five words on a sheet of tinfoil. At the Scientific American demonstration, they apparently played several sheets of tin foil, a series of performances which the editor glossed into one: "The Talking Phonograph," Scientific American, December 22, 1877, 384, reprinted in EP, doc. 1150, p. 670.

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October in a letter to Edison as a "wonderful invention in recording the human voice."[42] The editor of the Scientific American echoed the phrase in headlining Edward Johnson's letter a month later. New York newspaper writers followed this lead, calling Edison's phonograph "A Singular Invention" or praising its "Wonderful possibilities."[43] The reproduction of someone's recorded speech was as striking as that of photography, for outside the immediate circle of the inventor, his staff, and his technological rivals, there was no precedent.[44] To the public, it was a feat full of wonder and therefore without definition for future applications. Until some had been found, marketed, and accepted, the phonograph would remain anomalous, a novelty to be exploited on the basis of wonder alone at hearing one's voice, essentially recognizable, played back.

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[42]EP, doc. 1092, "From Benjamin Butler," October 23, 1877, p. 603.

[43]Reprinted in EP, doc. 1102, "Johnson to the editor," 615-17; quotes in 617, n. 1. The description has persisted; see Isom, "A Wonderful Invention," 657; and Iris Newsom, ed., Wonderful Inventions: Motion Pictures, Broadcasting, and Recorded Sound at the Library of Congress (Washington, D.C.: 1985).

[44]The Abbé Lenoir summarized Cros's conception in La Semaine du Clergé on October 10, 1877, and the paper was unsealed and read at the Académie des Sciences on December 5: Gelatt, 23-24; Biel, 51-52. Friedrich A. Kittler, in Gramophone, Film, Typewriter, translated with an introduction by Geoffrey Winthrop-Young and Michael Wutz (Stanford, Cal.: 1999), 21-22, is the first writer to examine Cros's hopes for his conception and his reaction to Edison's invention.

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Unlike Edison in his private ruminations, the editors of Scientific American had lofty aspirations for the phonograph. They were the first consumers of sound, and for them the appeal of recording lay in retrieving from the past the best thoughts, wishes, and performances. Orators and opera singers could leave their voices as a legacy. The recording of last wills and testaments would affirm the testator's sanity, and would also be useful for courtroom testimony. Even its application to entertainment offered more than amusement in its impact on the listener. When combined with stereoscopic magic lantern images, the phonograph record would provide the eery effect of making it "difficult to carry the illusion of real presence much further."[45]

Edison's agenda had little to do, however, with broad cultural possibilities. If he and other inventors of communications technology are to be regarded as conservative in the applications of new inventions, that description is easily justified by the uncertainty and expense of integrating new systems into society. In Edison's case, he was also conditioned by working on systems designed for commerce, not mass consumers.[46]

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[45]"The Talking Phonograph," Scientific American, December 22, 1877, reprinted in EP as doc. 1150, pp. 670-72.

[46]For an extended argument that uninformed speculation and comment on electrical technologies, including the phonograph, are crucial to their conservative integration into American culture, see Carolyn Marvin, When Old Technologies Were New: Thinking about Electric Communication in the Late Nineteenth Century (New York: 1988), 3-8, 75

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Perhaps most importantly, he defined invention as something that filled a given need. The phonograph for Edison was an accident, a discovery.[47] It was therefore easier for him to break away from using the phonograph to solve the problems that stimulated its development. It was also easy to fall into the error of continuing to demand that the record accomplish two tasks, recording and reproduction, not one.

Whether his creations were progressive or conservative in nature, Edison was interested in as rapid a return on investment as possible.[48] To that end he filed for a patent on Christmas Eve, which he received less than two months later (U. S. Patent 200,521). On January 24, 1878, he sold the manufacturing and sales rights, capitalized at $50,000, to five investors who formed the Edison Speaking Phonograph Company. In return, Edison received $10,000 and a twenty percent royalty on all machines sold. He also sold off rights to two groups that had little success developing and marketing phonographs for toys and clocks. The delicacy of the technology was not up to miniaturization, much less mass production.[49]

80, 203-208.

[47]Josephson, 158.

[48]Ibid., 137-38; Conot, 460-61.

[49]Gelatt, 22, 26; Read and Welch, 25, date the incorporation on April 24; Conot, 110; R. Wile, "Edison," 17-18.

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What did the Phonograph Company receive? There were no illusions about the practicality of the device; an early ad for prospective exhibitors acknowledged that the phonograph was not yet developed for "the practical uses of commerce" and that it was offered in a form "best adapted . . . as a novelty." To provide a usable playing time, Edison returned to his long-cylinder phonograph but could not find an effective motor at the right price for his purposes. Even as he sold the rights to talking dolls based on the technology, Edison acknowledged that "no one but an expert could get anything intelligible back from it."[50] To record, one had to carefully mount a sheet of heavy tin foil on the cylinder. Without a drive from a spring motor, the cylinder had to be cranked at a consistent speed for about a minute of recording. Since these longer recording proved difficult to replace if removed, the operator had to crank them backwards for playback. Reproduction of declining quality lasted for three or four repetitions before the stylus destroyed the indentations; these were not precise enough for a

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[50]For motors, expense, and design, see Israel, 150, 151; EP, doc. 1149, "To James MacKenzie," December 12, 1877, p. 670; doc. 1153, "Edward Johnson to Uriah Painter," December 17, 1877, pp. 678-79, n. 9; doc. 1154, "To Thomas David," December 22, 1877, 678, n. 3. For the talking doll venture, see doc. 1158, "Edward Johnson to Uriah Painter," December 24, 1877, p. 684, n. 5. Edison quoted in Gelatt, 26.

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listener absent during recording to make out the articulation of certain consonants, especially the letter 's.'[51]

Nonetheless, for twenty-five cents a head, some twenty-five thousand members of the public paid for the opportunity to hear Edison's records.[52] One observer recalled, however, that the audience constituted "the most unmusical Americans you ever saw." She saw only "a dingy looking brass toy with a funny looking brass horn," out of which came "a veritable nightmare of hideous sounds, and a man's voice harsh, strident, and raucous . . . grinding out in hoarse metallic notes a classic of the day, 'The Man in the Moon is Looking, Love, is Looking, Love!' . . . One wag in the crowd suggested playing the little toy backward, to see if it would play any worse!"[53]

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[51]Biel, 76-77; Gelatt, 30-31; R. Wile, "Edison," 16; William H. Preece in Gelatt, 31; operating instructions reprinted in Theodore Du Moncel, The Telephone, the Microphone, and the Phonograph (New York: 1974 [1879]), 249-51, n. 1; and Du Moncel's evaluation in idem, 246. See also comments on efforts to recreate the first recordings in Edward Jay Pershey, "Drawing as a Means to Inventing: Edison and the Invention of the Phonograph," in Pretzer, 112.

[52]I have derived the number of listeners in 1878 from Edison's earnings of $1,000 from exhibitions, which represented twenty percent of net receipts after payment of a manager. If we accept the manager's salary at a $1,000, the gross would have been $6,000, or 24,000 customers: see Israel, 150-51.

[53]Quotes from Marion M. Suck to the editor, The Phonograph Monthly Review, September 1927, 512; see also Gelatt's account of a performance, 27-28.

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Over the first half of 1878, the Edison Speaking Phonograph Company produced about 500-600 phonographs for exhibition. With profits reported for one machine of up to $1,800 a week, Edison and his team pursued further developments in format and record material. Besides making incremental or stylistic improvements to the exhibition phonograph, he tried a disc phonograph, on which the foil could be mounted more easily, and from which recordings might easily mass-produced. The limited size and playing time meant, however, that the reproduction degenerated as the stylus moved toward the center of the disc. This was an inherent problem in the format. As the speed of the disc progressively slows down relative to the stylus as the stylus tracks the groove toward the center, the higher frequencies, represented by numerous small waves, were compressed and distorted, or eliminated beyond a certain number.[54]

Edison also retained the use of metal foil for a number of reasons. He had made the experimental distinction that recording and reproducing styli had different requirements for maximum effectiveness, and realized the same held for the record material. A softer surface, like paraffin, promised better recording, but Edison had not overcome the clogging of the stylus's movement as the wax piled up. Most importantly, he also needed louder

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[54]Read and Welch, 20; Gelatt, 27-29, 32; Conot, 107-109; Pershey, "Drawing as a Means to Inventing," 112-13, Israel, 151-52.

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reproduction for the purpose of lecture demonstrations.[55] This required stiffer groove walls that would transfer the force of the stylus's movement to the diaphragm. At this time, lacking any competition for articulation and seeking large audiences for the demonstrations, Edison valued loudness over clarity.

Thus, when in April Edison filed for British and American patents on every improvement he had conceived, they continued to center on metallic surfaces for recording and electrotyped reproduction.[56] His major mistakes here were two-fold. One lay in describing the recording process only as one of "indenting," or moving the record surface, and not including "engraving," or removing the surface. The other was filing the final British specifications before the American ones late in 1878. In keeping with standard practice at the time, the U. S. Patent Office denied the claims already covered in the British patent.[57]

Edison continued to promote himself as an inventor/entrepreneur by encouraging reporters to visit his lab, where he showed off further

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[55]See Edison's and Batchelor's testimony quoted in R. Wile, "Edison," 16. Israel, 152, indicates that Edison's retention of tin foil stifled the phonograph's development without explaining the inventor's motives.

[56]Read and Welch, 14; British patent reprinted idem, 28A-T, especially 28G.

[57]R. Wile, "Edison," 18-19.

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experiments on cylinder and disc phonographs in the spring of 1878. In an article for the North American Review, best known for his predicted applications of the system, Edison focused on the strengths of the phonograph as it applied to business purposes. He demurred on the challenges of removing and replacing the tin foil after recording, and claimed that a sheet rotated on a disc could contain up to forty thousand dictated words inexpensively. Mass reproduction of the records was of less concern; Edison reported that he had recently heard of, but not accomplished himself, the electrotyping of copies.[58]

Whatever pattern there was to the list lay in an emphasis on commercial applications: business dictation came first and telephonic transmission last. Consumer use, for musical reproduction or home recording, fit squarely in the middle. Six months into the promotion of the phonograph, Edison still had little sense of who might find recording useful. Lacking a rising response to his ten-dollar "Parlor Speaking Phonograph," he returned to the contexts of of the device's invention and the commercial market with which he was most familiar. The article closed

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[58]Israel, 152; Thomas A. Edison, "The Phonograph and Its Future," North American Review, May-June 1878, as substantially reprinted in Du Moncel, 255-58. Assuming a very high dictation rate of two hundred words per minute, Edison was claiming a recording time of three hours and twenty minutes for his tin foil sheet.

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with two pages embroidering applications linked to the telegraph and telephone.[59]

The article has been recalled for Edison's prescience regarding the phonograph's future applications, but there was little in his list that he or other writers had not already considered.[60] More important were the the rankings in this list, or lack thereof, and Edison's definition of technical improvement, and the standard by which he would measure the improvement of the phonograph. Significantly, now that he had gained the public's attention, Edison abandoned the problem of volume. Nor was extended playing time an issue, assuming he could increase the volume of the cylinder. The key lay in improving the fidelity of sound "upon the ear . . . as if coming direct from the original source."

What sound would best test the phonograph? Edison assumed the most popular recordings would center on the high cultures of grand opera and Anglo-American political speeches. Not coincidentally, he assumed that the voice of reigning prima donna, Adelina Patti, would set the

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[59]Gelatt, 28-29; Marsha Seifert, "Aesthetics, Technology, and the Capitalization of Culture: How the Talking Machine Became a Musical Instrument," Science in Context 8, no. 2 (1995): 424. For more on Edison's cultural conditioning regarding his phonograph and motion picture inventions, see Israel, 277-78; the ten-dollar machine was actually designed by Edward Johnson, Edison's promotional agent: Israel, 152.

[60]Gelatt, 26, 28-30; Seifert, "Aesthetics," 423-24.

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standard for technical quality as well as esthetic appeal.[61] Edison did not address how these recordings were to be disseminated in the absence of a method of mass reproduction.

Section V: The Fall of the Phonograph, November 1878

By the summer of 1878, as the phonograph fad wound down, Edison began to turn his interests toward the massive task of developing an electric lighting system and effectively shut off further development of the technology. In November he contracted his services exclusively to the Edison Electric Light Company for the next five years and bought the assets of the Phonograph Company.[62] In January 1879, Edison gained a release from further commitment to phonograph development. There was no easy way to develop a more practical device if, assuming that the phonograph had a market only in dictation, recording and reproduction had to take place on the same surface. The next year Edison dismissed what he had called his "baby" in 1878 as "a mere toy, which has no commercial value." Indeed, the inventor abandoned the issue of improving the record for the next seven years. With no further improvements and no practical applications, profits from sales and royalties declined from $4,450 in 1878 to $479 in 1880.[63] Late

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[61]Edison quote and analysis in Seifert, "Aesthetics," 424.

[62]Read and Welch, 26; Israel, 276.

[63]Koenigsberg, xxiii.

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in 1880 a dispirited employee told a reporter that the Company still produced "eight to fifteen a month" but that with Edison and Edward Johnson otherwise engaged, he did not believe that "the phonograph will ever be much further improved."[64]

After three years, it remained unclear who would use the phonograph, how to sell its capabilities, what qualities consumers would prefer, and how participants should define improvement. By the time Edison returned to his "baby," inventive rivals had not only realized improvements he had specified or tinkered with, but they also adopted his assumptions for its use in society. The linkage of the phonograph to the celebrity inventor, its association with other novel and profitable communications technologies, and the assumption of a commercial market as a dictation device all assured investment of time and money in its development.

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[64]Edison's quotes in Josephson, 171, 174; date of release, R. Wile, "Edison," 19, n. 34; employee's quote in idem, 19. See also Edison's dismissive attitude about the phonograph as related by a reporter for the Philadelphia Record in February 1880, reprinted in idem, 20.

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Chapter 2: Shaping the Sound of the Cylinder Record, 1878-1894

Section I: Introduction

With the evaporation of the novelty market, the phonograph record required some further stimulus to make it practical for any of the markets Thomas Edison had proposed, and to persuade the consumers in those markets that it was worth their money, time, and effort to make it part of their lives. This chapter follows the record as other sets of inventors improved and patented it, new groups of entrepreneurs engaged to sell it, and different markets of consumers responded to the presence and effect of a new object in their lives. The inventors included Alexander Graham Bell, Edison again, and Emile Berliner. Each of them established his own company to sell their records, first to the business community as a stenographic aid, then as a form of coin-operated amusement, and finally, as entertainment available in the home.

The consumers or users in each of these markets made demands on the producers with varying effect. Throughout the 1880s, inventors labored to improve the sound and other qualities of the record. With a new technology and uncertain markets, the existence of patents was not necessarily a barrier to innovation. The patents themselves had to be well composed and defended; a patent badly written and not coordinated with foreign filings was no good at all, as Edison discovered. Moreover, incomplete claims opened the door to other inventors working around the

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design. This multiplied the number of basic patents and led to considerable chicanery in the court system.

The incentive to defend the patent came with success in the marketplace. This in turn demanded a mixture of skillful marketing, or persuasion of the consumer to substitute a new device for a traditional technique, and a certain amount of real effectiveness on the part of the technology. The failure of the wax cylinder record in the purpose for which it was marketed led to the entrepreneurs' search for other applications. This required some creativity in their thinking outside the commercial paradigm that Edison and Bell had established for the record.

Late in the decade, with the discovery of consumers willing to pay to hear recordings rather than make them, and with Berliner's efforts to mass-produce copies of records for the home consumer, entrepreneurs settled on their formats. Aided by the inventors, they made only incremental changes in the record and concentrated on improving production techniques and selling to an expanding market even as they competed for larger shares of it.[1]

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[1]James M. Utterback noted this pattern in "The Dynamics of Product and Process Innovation in the Industry," in Christopher T. Hill and Utterback, eds., Technological Innovation for a Dynamic Economy Pergamon Policy Studies on Science and Technology (New York: 1979), 40-65, and has since expanded on it in Mastering the Dynamics of Innovation (Boston, Mass.: 1994). John B. Stewart, in "Functional Features in Product Strategy," Harvard Business Review, March/April 1956, 65-78, offered some evidence of higher rates of features offered early in a product cycle for mid-century durable goods.

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Berliner, a late arrival to the field with few links to the community of cylinder backers, developed a disc record tailored for mass production and the home market. His work suggests that, as an outsider, he perceived a presumptive anomaly in the mass-production of cylindrical records. A more practical alternative than pantography or leather-lunged performer lay in a relatively two-dimensional disc which could be stamped rather than molded. This was not a scientific insight, for both Edison and Bell's group had experimented with flat records. They stayed with cylinders for technical and commercial reasons, however, leaving Berliner to try to find a way around their basic patents on making a groove.

His experiments led to a second breakthrough, in the use of a material much harder than wax for the record. Berliner's use of shellac occurred almost by accident, and so perhaps was his insight of letting the groove's motion under the stylus drive it and the diaphragm. This technique provided a louder sound for the listener, eliminating the need for the eartubes originally designed for office and public spaces. At the chapter's end, however, he was still looking for technical and commercial assistance to take his gramophone from novelty to the consumers he imagined.

Section II: The Volta Laboratory's Re-Invention of the Record, 1877-1884

When the news spread of Edison's phonograph in December 1877, Charles Cros was not the only inventor aggravated by the acclaim. Alexander Graham Bell was the third generation of his family committed to

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teaching the deaf, and he had been ecstatic at gaining access to a phonautograph at the Massachusetts Institute of Technology in 1874. Fascinated by the prospect of showing the deaf visible displays of properly pronounced speech, he tried to adapt the device to do so more effectively; it appears that manipulating one adaptation a bit further would have led Bell to the phonograph three years before Edison.[2] He toyed again with the possibility of reproducing the sound tracings on glass a couple of years later, while lecturing on the telephone. In recollecting these paths not followed, he berated himself: "It is a most astonishing thing to me that I could possibly have let this invention slip through my fingers. . . . the thought never occurred to me to indent a substance and from the indentations to reproduce sound."[3]

Nonetheless, Bell complimented Edison on his device, conceived independently the mass electroplating of copies, and evaluated the phonograph for its application in deaf schooling in the spring of 1878. Unlike other men's criticism of soft consonant articulation, however, Bell found the phonograph incapable of distinguishing between the long vowels "ee" and "oo." He too concluded that in Edison's configuration it was

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[2]Robert V. Bruce, Bell: Alexander Graham Bell and the Conquest of Solitude (Boston: 1973), 102-103, 111-12.

[3]Quoted in ibid., 252; and at greater length in Raymond R. Wile, "The Development of Sound Recording at the Volta Laboratory," ARSC Journal 21, no. 2 (Fall 1990): 209.

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"merely a highly interesting & ingenious toy." While innovation offered considerable promise, Bell's two proposals for commercial exploitation reflected the contexts of his first impression. One was to have his assistant Thomas Watson produce thousands of toy noisemakers; the other was to develop a personal alarm device, which reflected his concern for his deaf wife's safety.[4]

Bell pursued neither of these options, however, and for three years worked on the transmission of sound by a selenium photocell. This represented his final work on retainer for the Telephone Company, which ended the association in 1881. Nonetheless, Bell retained an interest in the future of the phonograph through the offices of his father-in-law, Gardiner G. Hubbard. A major investor in and president of the Edison Speaking Phonograph Company, Hubbard was unhappy with Edison's neglect of the technology. He made Bell aware of Edison's inactivity in the years after 1878. To capitalize on this commercial and technical opportunity, Bell began organizing a research laboratory in Washington, D.C. His receipt in 1880 of the French government's Volta Prize for scientific achievement in electricity, based on his invention of the telephone, gave him $10,000 with which to found the Volta Laboratory. Bell hired his cousin Chichester A. Bell, a physician and chemistry professor, to join him and Charles Sumner Tainter, an instrument maker with whom he had worked in Cambridge,

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[4]Bruce, 343, 253-54; quote on 253; R. Wile, "Volta," 209.

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Massachusetts. Their charge was to make the lab pay for itself by making the phonograph a commercial product; to what specific purpose, his biographer does not say.[5]

The Volta team had certain advantages over Edison's group at Menlo Park. It was exclusively interested in sound recording and reproduction, and once the photocell project was completed, Bell and company were under no pressure from an outside contractor. Nor were they forced by the need to be first in the field or the financial interests of the group's leader to market the product before its time. As it turned out, Alexander Bell was only peripherally involved with the lab work, but he remained in close contact with his associates and developed legal relationships that divided potential profit from Volta inventions to the satisfaction of all involved.[6]

The Bells and Tainter set two technical goals: greater fidelity, which Tainter approached through the relationship between stylus and record; and record durability, on which Chichester concentrated by virtue of his training in chemistry.[7] Although they experimented with an enormous range of recording methods, formats, and surfaces, often repeating the work at Menlo

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[5]Bruce, 335-43; R. Wile, "Volta," 210-11.

[6]R. Wile, "Volta," 212-13.

[7]Bruce, 350. The Bell referred to during the graphophone's development in the following pages is Chichester.

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Park, their ultimate settlement suggests the limits of what was technically possible for commercial production at the time.

To attain a longer lasting record, Bell and Tainter experimented with magnetic, compressed-air, and light-beam reproduction, all of which required little to no contact with the record surface.[8] Although they received patents on the first two methods, neither was as practically effective as a stylus in contact with the motion of the groove. Examination of an Edison phonograph led to two insights in this area. First, indentation had the effect of merely displacing the tin foil. In practice this meant that movements of the stylus on the foil pushed some of it backwards, distorting earlier indentations. Second, tin foil had a certain amount of elasticity that impeded accurate tracing.[9]

This analysis led to patents for a floating, or damped, stylus which maintained a lighter and more consistent pressure on the recording surface, and for the engraving, not indenting, of a record.[10] Edison experimented with the latter approach in the course of his work with waxed paper strips, but when writing the patent he or his lawyer evidently overlooked the distinction. The Volta lab's use of a parafin-wax compound, however,

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[8]Ibid., 343, 350-51; R. Wile, "Volta," 213, 214-15.

[9]Bruce, 350-53; R. Wile, "Volta," 211.

[10]Bruce, 343, 352-53.

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indicated the conflict inherent in the competing demands made on a phonograph where the same record was used for recording and reproduction. The sound was clearer because of the softness of the medium and the delicacy of the stylus, but it was also less enduring.

As for the format, Bell and Tainter oscillated between the alternatives. A continuous line could be traced most efficiently as a spiral on a disc or a cylinder. The line could reproduce the soundwaves vertically, in the "hill and dale" fashion of Edison, or laterally, in what they called "zig-zag." All involved trade-offs between distortion, playing time, and efficient storage. Slower playing speed eliminated higher frequency sounds when the needle became unable to trace the tighter waves. On the other hand, a higher velocity stretched out and flattened the waves, dampening the loudness of lower frequency sounds by reducing the movement of the stylus and diaphragm. Some medium had to be found that compromised between the needs to reproduce frequency and dynamic ranges as well as sustain a practical playing time. In a cylinder this might be resolved by increasing length or width. In the first case, "hill and dale" engraving on a small-diameter cylinder would eliminate high frequency waves at a given speed when compared to a cylinder of larger diameter. But any increase in the diameter meant a geometric increase in the volume of the cylinder. This volume represented wasted space and added to the fragility of the record.

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As for the direction of the movement of stylus, engraving vertically offered the prospect of greater density of grooves per inch. This exaggerated the force of the stylus, however, as it worked with and against gravity. Lateral engraving offered more balanced recording of the soundwaves, but a wave of extreme amplitude would overcut the preceding and following grooves on a record. Here a compromise was necessary between playing time and compressed dynamic range.

Disc recording only aggravated all of these considerations. The cylinder rotated at a constant speed under the stylus. The movement of the disc under the stylus, however, meant that the stylus travelled unequal distances in a given time between outer and inner grooves. As Edison had discovered before, this resulted in further compression of high frequency waves towards the center of the disc. Bell and Tainter developed a variable-speed motor to maintain a constant speed of the record under the stylus, but it proved mechanically complicated and commercially impractical.[11]

The duo settled on the vertically recorded cylinder. In doing so they followed not only Edison's paradigm but also an assumption of Alexander Bell's and their own goals for innovation. Bell's success with a heavy diaphragm in developing the telephone led him to the analogy that a

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[11]Bruce, 354; Oliver Read and Walter L. Welch. From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed. (Indianapolis: 1976), 36, and drawings for Bell and Tainter U. S. patent 341,214, reprinted in idem, figs. 3.5A-D, 32-35.

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similarly heavy diaphragm would improve on Edison's phonograph. This was not necessarily true, and Tainter and Chichester either failed to change his mind or did not dispute the approach. The added mass of the pickup, however, resulted in overcutting in lateral recording.[12] Furthermore, all else being equal, the cylinder offered the consistency of constant speed. Its disadvantages lay in its physical inefficiency, given the volume enclosed by the recording, and the complications of duplicating a three-dimensional format.

Neither of these factors directly affected the Volta team's goals of fidelity and durability, unless one separated the record made from the record reproduced. A record that served both purposes inhibited repeated playback and mass production of recordings. The Volta group never took the technology in this direction, although Alexander Bell refined the vocabulary of the technology to reflect its two-sided nature as well as to separate the Volta work from Edison's. He described the Volta machine as a "graphophone," which reproduced sound made on a "phonogram," or a record. Edison's machine was a phonograph, something that recorded sound; when used for reproduction, it became a graphophone.[13] The distinction, however, seemed to lie only in the Volta inspiration of using different pickups for recording and reproduction.

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[70]Bruce, 350, 366.

[71]Ibid., 350-51.

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Since the wax cylinder met the first goal at the expense of the second, it is worth asking why the Volta group did not persist with electroplating a wax disc to gain a harder surface. Again, there were technical, commercial, and personal issues complicating what might appear self-evident in retrospect. In the first place, the wax cylinder offered better reproduction than a wax disc, if costs were fixed, because of the advantage of constant speed. Second, it stood to reason that if a disc offered inferior sound, copies made via electrotyping and reproduction would be even worse. Beyond these technical difficulties, however, lay those of the purpose of the phonograph and the lab's work on it. What good was the phonograph? Who would use it for what ends, either in recording or reproduction?

Alexander Bell was not the one to answer those questions. He had little of Edison's monomaniacal devotion to systematic innovation. His needs for recognition and financial security had been sated by his invention of the telephone, where he had been able to leave commercial issues to his father-in-law. Invention did not define his life as much as provide a poorly structured outlet for his relentless curiousity. This in turn overwhelmed his willingness to pursue an insight to commercial fruition. In the case of the Volta Labs, where he played little direct role because of other interests, it meant that his cousin and Tainter lacked direction. Without knowing the

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purpose of the phonograph, they did not know which of its qualities they should improve.[14]

After all, Tainter and Bell had accomplished their significant work in 1881. Apparently fearing either that their technology was not significantly different from Edison's or that the one year's protection afforded by a caveat would be insufficient for further development, they had placed the crucial parts of their innovations, along with an explanatory letter and supporting documentation, in a sealed biscuit tin in October 1881 and deposited it with the secretary of the Smithsonian Institution. Over the next three years, the group exhausted the Volta prize money and gained another subsidy from the Telephone Company while attempting further improvements, but by the fall of 1884, Chichester Bell apparently tired of the endless tinkering. He gave notice for his return to Great Britain the following May.[15]

With the dissolution of the laboratory and with it the end of the Telephone Company's subsidy, Alexander Bell finally steered toward commercialization. This was, for him, the lesser of two evils; alternatively, he and Tainter could devote "much labor and time" to improving "the character of the reproduced speech so that it may be clearer and more distinct than it is at present." Bell was not one, however, to "ever expect perfection. There is nothing perfect in this world." Without a durable

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[72]Ibid., 355, 365-68.

[73]Read and Welch, 28-31; R. Wile, "Volta," 213-16.

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recording, Bell, like Edison, could see no practical use for the machine beyond that as an additional step in office dictation, and innovation in that direction required investment he could no longer afford. The appeal of the present system lay in its convenience to management, and Bell therefore encouraged Tainter to reduce the size, weight, and complexity of the graphophone with an eye toward production.[16]

The year 1885 marked a watershed for the phonograph. There were now two working systems, each with its own flaws and patented strengths. The potential for a market existed, shaped by the design goals of Edison and Bell and expressed in the faith of small groups of investors and stenographers. The wax graphophone cylinder represented a marked improvement in sound over Edison's tinfoil wrapping, but its backers would have to come to terms with the latter system's jealous inventor.

On June 25, 1885, Volta Laboratory's patent attorney filed nine wide-ranging patent applications. One of the claims that would lead to lengthy court disputes specified a six-inch cylinder phonograph using a $1^{5/16}$-inch diameter cardboard tube coated in white beeswax and paraffin. For business purposes, a cylinder enabled easier cueing and searching than a disc; for the playing time necessary to dictate a one-page letter, vertical engraving permitted a pitch of 125 grooves per inch; for consistent contact with the groove, Tainter's damped stylus provided better recording and reproduction;

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[74]Quotes in R. Wile, "Volta," 216-17.

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and for more constant speed of rotation under the stylus, a battery-powered motor or a foot treadle was superior to a handcrank.[17]

There is little commentary on the system's quality of reproduction. In 1937, officials at the Smithsonian Institution opened the tin containing the graphophone that the Volta group had deposited there in 1881. On playback Alexander Bell's daughters could not determine if the voice was his. One listener noted that by reading an enclosed transcript, "you could make out a word now and then from the shrill voice," and that the recording "was more nearly discernible if you used the old earphone attached to the device" rather than the electronic amplifier and speaker that officials had somehow attached.[18]

Considering that the cylinder suffered from over fifty years of temperature changes that melted and expanded the wax and cardboard to different degrees, it is surprising that a later generation heard anything at

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[17]Bruce, 352-53; Allen, Koenigsberg, ed., The Patent History of the Phonograph, 1877-1912, (Brooklyn: 1990), xxiv; Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, 2d ed. (New York: 1965), 35; Read and Welch, 37. Gelatt includes a contemporary illustration of an "early motor-powered graphophone." Read and Welch, figs. 3.6-3.8, 36-37, show a patent model hand-powered by a "heavy drive wheel."

[18]"Voice Recorded in Was by Bell 56 Years Ago Heard as Original Graphophone is Unsealed," Washington Post, October 28, 1937, 1; quotes from "Bell's Original Graphophone Speaks After 56-Year Silence," Evening Star (Washington, D.C.), October 28, 1937, B-1.

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all.[19] In the 1880s, however, it was apparent that Tainter's changes offered higher fidelity and more playing time than Edison's tin foil record. The fidelity gained by recording in soft wax came at the expense of far quieter reproduction, but users might regard a rubber pipe and ear horn as advantages in an office.[20]

The problem in going to market lay in the need for capital for further refinements to a production model and the uncertainty over the patent situation. Edison had erred by failing to file simultaneously for American and British patents in 1877 and 1878. United States law denied coverage at the time to anything patented earlier in a foreign country, and American protection expired when the first foreign patent did. Edison's British patent covered almost all of the Volta group's improvements, but it is unclear when the group realized that its expiration in April 1885 made their patents the only applicable ones in the United States.[21] Lacking that knowledge, the Bells and Tainter needed Edison's license to add their improvements to his basic patent.

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[19]Raymond Wile, "Cylinder Record Materials," ARSC Journal 26, no. 2 (1995): 163.

[20]Bruce, 352-53; Wile, "Volta," 217-18; Gelatt, 35.

[21]R. Wile, "Volta," 219, n. 41; Raymond R. Wile, "Edison and Growing Hostilities," ARSC Journal 22, no. 1 (Spring 1991): 8. Allen Koenigsburg suggests that Edison allowed the British phonograph claims to lapse in order to protect the more valuable telephone portions of the same patent: see Koenigsburg,xxii.

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As Bell's father-in-law and president of the moribund Edison Speaking Phonograph Company, Gardiner Hubbard tried to bridge differences. He raised the prospect of a partnership in early July with Edison's associate and the company secretary, Edward H. Johnson. Johnson initially rejected the idea; to have any standing with Edison, the graphophone had to be reduced to practice. To that end he referred Bell and Tainter to Bergmann and Company, which had built many of Edison's phonographs and in which Edison had an interest.[22]

The Volta group initially contracted for ten cylinder and ten disc machines, but with tight finances settled for six of the former, which Tainter favored for dictation. Chichester Bell preferred the disc but, having made known his intention to leave, was in no position to force an equal commitment, and Alexander Bell, never closely involved with the practical engineering or applications, did not care. Tainter's further refinements and Bergmann's reluctance to commit staff slowed progress. Tainter finally took one back to Washington to finish for Johnson, and by the end of September, he had the cylinder graphophone in working order.[23]

After the successful demonstration, Tainter proposed a merger, offering to divide equally shares for invention. Although not directly involved in the negotiations, Edison had been fully aware of the Volta

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[22]R. Wile, "Volta," 217-18.

[23]Ibid., 217-18.

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group's progress.[24] Seeing that much of the Volta work was based on his expired British patent, he refused Tainter's offer.[25]

The Volta group decided to move forward independently. Over the winter and spring of 1886, they received notice of approval of their patents, incorporated the Volta Graphophone Company to administer them, and began public demonstrations in the District of Columbia. These gained the attention of some congressional and court reporters, who saw a device that would cut one step of transcription out of the labor-intensive process of stenography. They organized the American Graphophone Company to market graphophones in the spring of 1887, exchanging shares with Volta in return for the license.[26]

Tainter and Chichester Bell also continued their overtures to Edison, meeting with his secretary in May. Edison was astonished that they had received patents and outraged by the offer of the "specalators." The intensity of his outrage stemmed from his special affection for his discovery, the Volta group's use of his once-patented ideas, and the fact that he had made his public reputation on the phonograph and the myths that surrounded its

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[24]Ibid., 218, 218 n. 34; R. Wile, "Growing Hostilities," 9.

[25]Read and Welch, 28; Edison's British patent no.1644 reprinted in idem, 28A-T.

[26]Bruce, 354; R. Wile, "Volta," 219-20.

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development.[27] All of this reinforced Edison's need to reclaim the device as his own, or at least to provide the best version.

Section III: Edison Responds, 1887-1888

Innovation did not come as quickly as Edison invariably claimed that it would. Two and a half years passed before he and his staff overcame an array of technical and commercial difficulties. Reducing design to practice was one thing; reducing practice to production was another, and reducing manufacture to marketing was a third. These steps were more interrelated than successive, and both Edison and the graphophone interests found the process a frustrating one.

Edison began protecting his market as early as December 1885, when he discussed developing his phonograph into a stenographic machine in an interview.[28] Other business concerns and marriage occupied him for much of the next year, and it was not until October 1886 that he and a fellow inventor-entrepreneur, Ezra Gilliland, began to design an office phonograph. Still concerned with avoiding patent infringement, Edison envisioned a motor-driven device where an interchangeable cylinder was painted with shellac or wax and could be transferred, along with stylus and

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[27]Conot, 260; Matthew Josephson, Edison: A Biography (New York: 1959), 318, puts the meeting a year earlier but still bases his date on the secretary's 1887 memo; idem, 171; Andre Millard, Edison and the Business of Innovation (Baltimore: 1990), 63.

[28]Conot, 246.

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diaphragm, to other machines. The new user would dissolve the recording after hearing it and recycle the cylinder.[29]

The effort to design around the Bell-Tainter patents continued as Volta began marketing the graphophone in New York in May 1887. That summer it earned enough positive response at a business education convention for American Graphophone to contract with the Western Electric Company for the manufacture of 300 of the devices. At the same time Tainter and Chichester Bell were equally fearful about the potential commercial conflict and finally obtained a meeting with Edison in October.[30]

By this time Edison was immersed in the construction of his new laboratory and plant in West Orange, New Jersey. Confident that he could outstrip the Volta improvements when production started, Edison essentially bluffed with the demand that he receive three-fourths interest and use of his term, "phonograph," for the product. In his opinion, Tainter and the Bells were a "bunch of pirates" profiting commercially from what he had exploited only as a novelty.[31] Tainter conceded the name change but would not accept less than half credit for the improvements to which he

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[29]Conot, 246-47; Raymond R. Wile, "Growing Hostilities," 11.

[30]R. Wile, "Growing Hostilities," 10, 12; idem, "Volta," 221.

[31]Quote in Bruce, 353, and Conot, 261; Gelatt, 36; Millard, Edison, 65.

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and his colleagues had devoted so much time and money. Edison might have conceived them first, but his neglect of his invention was apparent in fact and, as it transpired, in law.

The momentum gathered by the graphophone was not lost on Edison. The publicity had led to several inquiries about the phonograph.[32] For months, if not years, he had been convinced that there was no point in reviving phonograph research. Now, with the prospect of competition, a market, and the technical inferiority of his original machine, Edison revised his perspective.[33]

Between September 1887 and March 1888, Edison took steps to maintain control of the patents and profits that would accrue with a new machine. He formed the Edison Phonograph Company with the express intent of innovating the system for business purposes; rejected the claims of the Speaking Phonograph investors to his new business; and ignored continued invitations to merge with American Graphophone.[34] The capitalization of Edison's phonograph companies indicates how high the financial stakes had risen in nine years: $50,000 in 1878, $1.2 million in

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[32]R. Wile, "Growing Hostilities," 10-11.

[33]Conot, 245, 246-47.

[34]Conot, 264-65; R. Wile, "Growing Hostilities," 10-12.

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1887.[35] Like his promoter Edward Johnson in 1877, Edison touted his product in the press in order to retain his public title to the phonograph, to keep potential investors interested, to rationalize the impracticality of its operation, and to set expectations of sound reproduction that would ensure the disappointment of anyone who heard his rivals' system.[36]

Yet Edison actually had little to do with the technical improvements he desired. He delegated to Gilliland and Batchelor the task of combining the benefits of soft recording material with his indenting method and tin foil. The duo responded to this challenge by placing the foil over a blend of resin and waxes. They also struggled with improving the stylus and diaphragm, but the phonograph continued to produce "the old scratching noises."[37] Impelled by the value of the sales for which he would be responsible, Gilliland tried to improve the phonograph not by working around the Volta patents, but by adding features. He made it possible to stop recording, reposition the stylus at any point, and replay or record over

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[35]Read and Welch list an 1888 contract for the original company where $600,000 had been paid in capital stock, 38; R. Wile, "Growing Hostilities," 13. These sums do not cover the value of companies established for toys or clock phonographs in 1878 or for Gilliland's sales company in 1887.

[36]Gelatt, 36; Millard, Edison, 67-68. Marsha Seifert, "Aesthetics, Technology, and the Capitalization of Culture: How the Talking Machine Became a Musical Instrument," Science in Context 8, no. 2 (1995): 425-26, neglects the issue of competition in Edison's public strategy.

[37]Conot, 260.

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earlier indentations. He also arranged for duplicate copies and the use of mechanical or electrical motors. These made it theoretically more appropriate for business purposes, but Gilliland remained frustrated with the basic sound quality.[38]

Edison agreed and, with the completion of his new facilities, decided to take another chance. If the Volta improvements had already been disclosed, as he believed they had by his British patent, then the graphophone patents were invalid and the phonograph field was wide open. Then Edison could improve on his device as he saw fit.[39] As for the formation of his new company, there were legal risks, but they were not overwhelming. Edison had offered a substantial share in his new company to the Speaking Phonograph stockholders, who knew that requirements for incorporation had not been met since 1878.[40] Now, in considering the prospect of a dispute with Volta, he had seen too much time and money wasted in court disputes over other patents.[41] He was not interested in suing the graphophone men, and he did not believe they could count on a

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[38]Conot, 261-62; R. Wile, "Growing Hostilities," 16.

[39]R. Wile, "Growing Hostilities," 11, 13; Millard, Edison, 68.

[40]Conot, 264; R. Wile, "Volta," 221; idem, "Growing Hostilities," 16-17.

[41]Josephson, 294-95, 354-55.

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favorable court decision, however strongly Tainter felt about Edison's neglect.

In January 1888, then, Edison committed himself and his corporate resources to the improved phonograph he had been promising since the previous fall. He assigned one lab group to develop a practical battery and electric motor. The problem here was twofold. First, the variations in the current affected the speed of the motor; second, the battery depleted quickly, for it had to start the movement of the steel mandrel, propel the stylus along its screw, and rotate the cylinder against the resistance of the stylus and soundbox. Moreover, he and his men could not devise a practical spring motor to power operation consistently through one cycle of recording and reproduction.[42]

He hired an industrial chemist, Jonas Aylsworth, to improve on the Volta wax-cardboard cylinder. Aylsworth and Edison switched to a thick wax layer on a metal tube with an eye toward shaving off old messages and recording new ones, but again Aylsworth struggled with the paradoxical challenge of recording and reproducing on the same record. How could he make a compound softer than Chichester Bell's that would take a more precise recording which at the same time would be hard enough to resist the greater pressure administered by the reproducing stylus? Between 1887 and 1889 he blended animal, vegetable, and mineral waxes into a white mass

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[42]Conot, 272; Millard, Edison, 68.

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that corroded the metal styli, forcing Edison to develop artificial sapphire tips. Aylsworth also had to ensure that the manufacturing process of melting, blending, cylinder-dipping, and cooling left no bubbles or cracks in the compound that would disturb the styli. This was no mean feat because Edison designed them to track no more than one mil into the wax in order to maximize use of the cylinder. When not working with Aylsworth, Edison, deaf as he was, had taken it on himself to improve the recording and reproducing styli and their linkages to the diaphragm. He relied on his assistants' evaluations of the sound quality when he did not bite or put his ear on the horn.[43]

The process of moving from design to prototype to mass production took fifteen months. Edison continued to improve the phonograph into December 1890, when he applied for the last of eighty phonograph patents he conceived in three years. By the spring of 1889, Edison's Phonograph Works was turning out nearly fifty Class M machines a day. These played a cylinder four inches long and two and a quarter inches diameter, designed to record at one hundred grooves per inch. Played at the recommended speed of one hundred revolutions per minute, a cylinder provided about two minutes of sound. The records, which would remain Edison's standard until 1902, consisted of a brittle metallic soap of stearic acid blended with

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[43]Peter Shambarger, "Cylinder Records: An Overview," ARSC Journal 26, no. 2 (fall 1995): 139; R. Wile, "Cylinder Record Materials," 163; Josephson, 318-21; Conot, 271; Millard, Edison, 69-71, 74.

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sodium and aluminum stearates and ceresin. The variations in the animal sources of the acid accounted for the variation in color from cream to dark brown.[44]

Overcoming the various engineering challenges was a task intertwined with those in publicity, financing, and marketing. Throughout this period Edison continued to promote his phonograph with mixed results. The failure of its operation in a demonstration to financier Joseph Seligman left Edison despairing over the prospects for innovation.[45] A demonstration at the Electric Club in New York in May 1888 led to more critical comment and a highly publicized "marathon" of inventive improvements.[46]

Section IV: The Stenography Market, 1888-1889

The technical delays also led to efforts by Edison and his associates to sell off parts of their interest out of desperation or cynicism. Gilliland in particular disliked the practical or legal prospects of his sales contract, and argued at length with Edison to sell the Phonograph Company to Pittsburgh manufacturer Jesse H. Lippincott. Lippincott had already bought sales rights

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[44]Koenigsberg, 3-8; Millard, Edison, 81, notes that Edison received seventy-five of these patents by the end of 1890; Gelatt, 39; Read and Welch, 47: fig. 4-3, 49, 60; R. Wile, "Cylinder Record Materials," 164-65.

[45]Gelatt, 38; Conot, 262; R. Wile, "Growing Hostilities," 23-24.

[46]Conot, 270.

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and manufacturing options to the graphophone and had seen Edison's phonograph. Apprised of the potential conflicts and transparently enthusiastic about the technology, he paid handsomely for the rights and put both phonographs and graphophones on the market. Edison and his group settled in July, leaving it to the glass tumbler magnate to market the machines.[47]

Lippincott built his business on the assumptions of the entrepreneurs of the time in the telephone and electric power industries. Assuming a limited but steady market, Gilliland had already licensed several phonograph companies to lease the equipment in specific regions, and Lippincott extended this structure under his North American Phonograph Company until there were thirty-three subsidiaries. Each machine rented for forty dollars annually, proceeds dividing evenly between local and parent company.[48]

This approach was not a problem if the technology worked as advertised. Edison, however, had developed a dictation system with multiple flaws. It weighed a hundred pounds, lacked a stenographer's mobility and endurance, and required far more delicate handling to cue the styli to the fragile grooves. The batteries tended to leak acid on the office floor while the stearic acid in Aylesworth's cylinders, rendered from beef

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[47]Gelatt, 41-42; Conot, 265-69; R. Wile, "Growing Hostilities," 22-29.

[48]R. Wile, "Growing Hostilities," 23; Read and Welch, 43; Gelatt, 43.

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tallow, added to the smell. Edison's claims to the contrary, shavings from the recording stylus clogged the mechanism, the cylinders warped, and the batteries when full lasted for ten hours at most--whether or not someone was using the machine.[49]

The graphophone was even worse. It operated at twice the speed and 154-160 grooves per inch, to which some specialized stenographers on Capitol Hill and Boston adapted, but few others did. Both systems required careful, loud enunciation and ear tubes to hear the lightly recorded and amplified sound waves.[50] Lessees, as well as the stenographers for whom the devices portended unemployment, complained early and often. By the time the nineteen local companies met at their 1891 convention, only sixty-five of some 3,110 machines in use were graphophones.[51] Neither Edison nor American Graphophone had flooded the country as they and Lippincott hoped three years before. The phonograph was hardly more reliable as a business machine than it was as a component of girls' dolls, another

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[49]Gelatt, 43; Josephson, 331; Conot, 272, 309; Koenigsberg, xxviii; Millard, Edison, 79-80. While ten hours appears a reasonable time for battery life, presumably the batteries continued to draw current whether or not someone operated the phonograph.

[50]Koenigsberg, xxv.

[51]The Columbia and New England Phonograph Companies leased about half of the graphophones between them: Read and Welch, 493.

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venture where Edison had taken a considerable loss between 1888 and 1890.[52]

Despite the attention paid by well-heeled investors and profit-seeking inventors to making sound recording and reproduction a paying proposition, it took men with fewer preconceptions on both coasts to find the technology a popular role in American society. It did not lie in commercial dictation, foreign language instruction, home recording, or toys, although these served as minor applications for the technology. The record's future lay in delivering entertainment, and this was a far broader market than Edison anticipated when he began to make recordings in May 1889. The local companies had far more customers who would pay to hear two minutes of song or a vaudeville routine than to record a letter.[53]

Section V: The Coin-Operated Market, 1889-1893

To be sure, the idea of musical reproduction was not new. Edison included it among his first speculations on the uses of the phonograph, and the Bells and Tainter considered musical reproduction as an alternative sometime in 1886.[54] In the spring of 1888 Edison set up a "Music Room" next to his lab in West Orange, where he recorded classical as well as

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[52]Conot, 271, 311*; Millard, Edison, 81-82.

[53]Tim Brooks, "Columbia Records in the 1890's: Founding the Record Industry," ARSC Journal 10, no. 1 (1978): 6.

[54]Read and Welch, 37.

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popular musicians in order to test fidelity, gain publicity, and increase the impact of demonstrations. He also reserved the right that June to make prerecorded cylinders "of music, novels, opera, etc." in his contract with Lippincott, for which the latter would pay him cost plus thirty-five percent.[55] Still, there is no evidence that he pushed the local entrepreneurs to buy his cylinders; the demand came from below.

Six months after Edison began commercial recordings, entrepreneurs at two local companies gave evidence of new industries arising out of Edison's original system. In San Francisco, Louis Glass, proprietor of the Pacific Phonograph Agency, installed the world's first jukebox on November 23, 1889, in the Palais Royal Saloon about a block down Pine Street from his office. In a little less than six months, his patented coin-operated machine with four listening tubes earned over a thousand dollars, at a nickel per cylinder playback. Glass followed his discovery of the market for pre-recorded entertainment with the production of fifteen battery-powered "Numis-Motor Phonographs," through which he offered new records daily.[56]

In Washington, D.C., the investors of the American Graphophone Company, led by stenographer Edward D. Easton, organized the Columbia

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[55]Gelatt, 39; Conot, 263, 270; contract in R. Wile, "Growing Hostilities," 26.

[56]R. Wile, "Growing Hostilities," 23; Koenigsberg, xxix.

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Phonograph Company in January 1889 to market both formats, leaving American to manufacture the machines. Columbia was the only subsidiary to issue a dividend to its shareholders that year, but by its close congressional stenographers were returning hundreds of graphophones inexplicably beset with problems. In November, Columbia began publicizing its stocks of recorded cylinders to home "subscribers." Listeners could buy cylinders produced by Edison of orchestras, brass bands, and instrumental soloists, as well as local recordings of John AtLee, a forty-eight-year-old government clerk who moonlighted as an "artistic whistler."[57]

This new application of consumer entertainment led to commercial and technical complications. Ezra Gilliland and members of his family capitalized on the jukebox craze by incorporating the Automatic Phonograph Exhibition Company (APEC) late in 1889. Edison bought into the company and sold it the rights to public coin operation. During 1890 he recorded 100-200 cylinders a day for the jukebox market. The success of phonograph parlors and the demand for recordings, however, led lone inventors and the local companies to take matters into their own hands. One patent examiner took two years and 1500 pages to sort out over twenty interferences for coin-operated attachments to phonographs. An inability to

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[57]Fred Gaisberg, The Music Goes Round (New York: 1942), 5, 7; Jerrold N. Moore, A Matter of Records (New York: 1976), 6; Gelatt, 48; Brooks, "Columbia Records," 5-7, and "A Directory to Columbia Recording Artists of the 1890's," ARSC Journal 11, no. 2-3 (1979): 102, 105.

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stop other companies from adapting their stenographic phonographs destroyed the APEC.[58] As for records, the local companies purchased recordings from Edison and Columbia; duplicated their recordings on blank cylinders; or recruited local performers who were willing to repeat loudly and endlessly popular selections into as many as ten of the phonographs simultaneously. Vocalists, notable by their absence on the first brochures, had to develop not only endurance but the techniques of a "recording voice" that did not result in "a confused medley of harsh, grating, unintelligible sounds."[59] As Edison pointed out in 1887, the phonograph "would whistle and sing far better than it would talk," which helped explain the commercial success of AtLee and Edison's find, the so-called "Whistling Coon," George W. Johnson.[60]

The lack of standards in recording, design, or manufacturing led to commercial chaos as operators became frustrated by balky jukebox devices and customers by recordings that varied unpredictably in quality. By January 1891, as the criticism of phonographs grew, Edison tried to regain control of the entertainment market. He had already ordered the Works to

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[58]Raymond R. Wile, "Record Piracy: The Attempts of the Record Industry to Protect Itself against Unauthorized Copying, 1890-1978," ARSC Journal 17, no. 1-3 (1985): 21; Koenigsberg, xxxv.

[59]Gelatt, 47, 49, second quote cited on 53; first quote in Brooks, "A Directory," 103.

[60]Edison quote in Seifert, "Aesthetics," 430; Gelatt, 55; Conot, 310.

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concentrate on coinslot players; now, in May he took control of North American from the bankrupt and ailing Lippincott and began selling phonographs for $150 as well as leasing them. He stopped recording in the Music Room to prevent unauthorized duplication and ordered further research on mass-production of molded cylinders. In private and in the company publication, The Phonogram, Edison insisted that investors would be better off marketing the phonograph for business purposes rather than lowbrow entertainment.[61]

Edison was not being pigheaded in taking this approach, nor was he opposed to using the phonograph for entertainment. Beyond his interest in maintaining the reputation and his control of his favorite invention, the labor needed to make individual recordings and musicians' complaints about the quality did not justify the profits he received from Gilliland's company.[62] On the other hand, the profits on his machines and blank cylinders increased steadily as production and efficiency rose and accrued directly to Edison. He was also trying to blunt, unsuccessfully as it transpired, the APEC's perception of infringement on the exclusive rights he had assigned it.

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[61]Gelatt, 44-45; Millard, Edison, 85-86; Conot, 309-11; Koenigsburg, xxxv.

[62]Conot, 309-10; R. Wile, "Growing Hostilities," 27.

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Nonetheless, his cutbacks had something of the desired effect. Only nineteen of the local phonograph companies sent representatives to the annual convention in New York City in June 1891, compared to thirty-three the year before. Edison treated them to tours of his facilities in West Orange, New Jersey, and unveiled his improved diaphragm and pantographically recorded, six-inch cylinders, which could be produced from recordings sent in by the locals. From a master record, Edison could produce thirty copies at once, for each of which he would charge fifty cents.[63]

By serving two markets, business and entertainment, with one system, Edison provided those who bought or leased the improved phonographs the means by which they could make their own improved records from the cheaper blanks. In the effort to recoup local investments and captitalize on the novelty of the phonograph, sound quality was not an issue. No one discussed it at the convention, and the popular nature of the recorded performances seemed to require more concern with their content rather than their form. Given the cost advantages and convenience of local recording, the differences in sound that might arise from the experience and standards at the Edison Works staff could be offset by the talents of recorders

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[63]Read and Welch, 51-52; Koenigsberg, xxxii; R. Wile, "Record Piracy," 23.

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at the local companies, the best of whom would work for the major record labels in the next century.[64]

Despite the relative disinterest of the locals in his cylinders, between June 1891 and March 1893, Edison continued to publish their availability in monthly announcements. In the latter year, he supported the organization of the United States Phonograph Company in New Jersey, which duplicated his recordings and sold them directly to the local companies, avoiding North American entirely.[65] To limit the circulation of phonographs from one company's territory to another, he reorganized the North American company in April 1892, offering franchisees a royalty on phonographs that he sold directly in their respective territories. It took a year for the franchisees to exchange a reduced profit margin for guaranteed markets. In that time Edison observed a rising interest in home entertainment. He told his secretary in June that "one of the greatest fields for the phonograph was in the household for reproducing all that is best in oratory and music but I have never got anyone to believe until lately."[66] For the Columbian Exposition of 1893-94 in Chicago Edison demonstrated a "Household Phonograph," which featured a lighter motor and an optional recording

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[64]Read and Welch, 54.

[65]Ibid.; R. Wile, "Record Piracy," 23-24.

[66]Conot, 307, 312; quote on 312-13.

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attachment. The cylinders, specially produced for the display, were recorded with double the pitch of standard records and offered twice the playing time.[67]

Section VI: The State of the Home Market, 1894

The home market was not, however, virgin territory for musical reproduction. Within the music machine industry, inventors and manufacturers had continued to innovate more versatile and cheaper devices. Their success rested on converting their handmade records to the long strip or disc as the storage medium for a continuous stream of information. At the high end, Michael Welte patented in 1887 a pneumatically powered mechanism that played a prepunched paper roll instead of a pinned cylinder. He applied this to the orchestrions, ornate and complex multi-instrumental machines built by his firm in Germany and distributed in the U. S. by a branch in New York City. Only the wealthiest individuals could afford a $10,000 home entertainment system where the rolls alone cost twenty dollars, and Welte's control of the patent kept the principle from diffusing through the piano industry until the turn of the century. Nonetheless, Welte orchestrions set a standard of imitation performance against which all other machines would be compared.[68]

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[67]Ibid., 313; Read and Welch, 55.

[68]Q. David Bowers, Put Another Nickel In: A History of Coin-operated Pianos and Orchestrions (Vestal, NY: 1966; special publisher's ed., 1968), 7-14; Bowers, Encyclopedia of Automatic Musical Instruments (Vestal,

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In affluent households, families continued to wind up their music boxes. Swiss companies and craftsmen dominated the production of the handmade cylinder format. Powered by one or more spring motors, the cylinders played between a minute and an hour at low volume, and cost at least fifty dollars in the early 1890s. In the mid-1880s, however, German inventors and entrepreneurs in Leipzig developed machines that could play interchangeable discs stamped out of cardboard, zinc, or steel. One member of the three-firm oligopoly that dominated the industry established the Regina Music Box Company in Rahway, New Jersey, in 1892. Cheaper, more aggressively marketed, and louder than cylinders because of the power generated by the star wheel escapement, the disc machines drove the Swiss from the American marketplace between 1895 and 1905, during which time a music box retailed for as little as six dollars, and "tunes," not records, sold for sixty cents. Regina sold about 100,000 boxes annually by 1921.[69]

Middle-class consumers also cranked or pumped their roller or disc organettes. The American industry had its origins in 1876, and built in part on Edison's invention. The Mechanical Orguinette Company of New York first offered the "Trumpetto," and in 1878 the "Phonographic Cornet." Both used a punched paper roll, lung power, and a crank to imitate the instrument for only three dollars. Other companies developed at the same

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NY: 1972), 346-47.

[69]Bowers, Encyclopedia, 17-22, 51, 99-103, 143.

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time similar mechanisms in square oak boxes designed for table tops and costing between five and thirty-five dollars.[70] A year later, the Scientific American praised the Autophone as representing "the first successful invasion of the domain of music by automatic mechanism," which indicates how quickly the editors lost respect for the potential of the phonograph.[71] By the mid-1880s a thriving industry of small firms in Massachusetts and New York as well as Germany made and sold hundreds of thousands of the boxes playing an enormous variety of music on paper rolls, cardboard discs, and wooden pinned rollers. They promoted the devices through small advertisements, independent travelling salesmen, mail order catalogs, department and dry goods stores, and music stores. Over a span of twenty years, prices dropped to $3.25 for a hand-cranked player and as little as eighteen cents for a music roll; sturdier discs sold for fifty cents.[72]

The fact that these machines all produced musical tones successfully, if on a limited scale, at a low cost suggests how much the phonograph backers had to overcome in selling a machine that merely reproduced those sounds. Nonetheless, improvements in fidelity--that is, recognition by

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[70]Ibid., 739, 756, 761.

[71]Ibid., quote from article of June 7, 1879, reprinted on 757.

[72]Ibid., 740-41, 754-65.

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listeners of an individual's voice or a musical performer--indicated the means by which the phonograph record producers could surpass their competition. Phonograph records offered the prospect of marketing the celebrity of performers or artists, particularly that of singers if the backers of the rival formats could agree on a standardized system. By contrast, few music machine manufacturers offered interchangeability among their anonymous records, sometimes even with other players in their own lines. By the spring of 1894, Edison might have overcome the disadvantages of his insistence on battery power and high price of the phonograph and formally introduced it to the home market, even in the wake of the Depression of 1893. But here fate and Edison's foolish pride caught up with him. To understand how the father of the phonograph denied himself its commercialization for the third time, we need to review the history of his rival.

Section VII: The Rise of the Columbia Phonograph Company, 1890-1896

Edison could have profited handsomely if he had demonstrated any respect toward the graphophone and its patrons. Years before he had alienated Charles Tainter, and in the early 1890s he rejected the overtures of Edward D. Easton, co-founder and president of the Columbia Phonograph Company. Born in 1856, Easton was one of the Washington stenographers who had invested in American Graphophone in 1887. In the next two years, he received bachelor's and master's degrees in law at Georgetown

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University.[73] This training and his contact with other lawyers would serve him in good stead in making his Volta-based companies the dominant ones in the record industry in the 1890s.

While comfortable with the graphophone, Easton was less committed than the other founders to either its business application or its pride of place in the company. Of the four hundred machines leased in 1891, only fifteen were graphophones.[74] Having initiated Columbia's entry into the recorded music industry, Easton toured the country in the spring of 1890, visiting thirty-one of the local companies to hawk his one- and two-dollar recordings. He also promoted the industry convention he arranged for May in Chicago. At the meeting, Easton led a unanimous agreement on the need for a single format, one that combined the popularity of the phonograph with some of the features of the graphophone.[75] Afterwards, he tried to meet with Edison, who had not attended, to propose ten improvements. Despite Samuel Insull's endorsement that Easton was "the most intelligent man in the phonograph business," Edison ignored him.[76]

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[73]Who was Who in America, vol. 1, s.v. "Easton, Edward Denison."

[74]Read and Welch, 51, 493.

[75]Brooks, "Columbia Records," 10-11; Read and Welch, 44, 48-49.

[76]Timothy Fabrizio, "The Graphophone in Washington, DC," ARSC Journal 27, no. 1 (Spring 1996): 7; quote in Conot, 312.

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Without the alliance necessary to change the hardware, Easton returned to developing Columbia's record catalog. In 1890 Columbia contracted with the United States Marine Band for recordings. A catalog sheet for October listed forty-nine selections, available for two dollars apiece. A month later the total grew to seventy-three. In the next year, Columbia's catalog swelled from four pages to fourteen. At the same time, a month after the 1890 convention, Columbia began advertising its nickel-slot automatic phonographs. By November Easton had over a hundred of the machines collecting coins in the Baltimore-Washington area, and the number rose forty percent over the next twelve months.[77]

While most companies in the northeast continued to make business leases their predominant source of income, others focused on the entertainment market.[78] It was not hard for Easton to see where the future of the industry lay. Service costs on the business equipment ate up the leasing charges; in Washington, he maintained a corps of technicians on bicycles to keep the machines in order.[79] His interest in Columbia records

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[77]Brooks, "Columbia Records," 7-8, 10, 12. The poll of machine usage at the 1891 convention indicates that Columbia was leasing only twenty-five machines for jukebox operation: Read and Welch, 493. The difference between Easton's claims and the poll may lie in the original leasing terms for each machine.

[78]Read and Welch, 493; Brooks, "Columbia Records," 10.

[79]Brooks, "Columbia Records," 10.

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was simple: assuming he bought the blanks from Edison's works, the rest of the profit accrued to Columbia.

Easton still worked to reduce costs. To achieve that end in recording, where a a soloist received between fifty cents a day and a dollar a round of recording before three phonographs,[80] Easton began acquiring duplication patents, including the first practical form of pneumatically powered pantographic duplication in May 1892.[81] To prevent listeners from substituting slugs, wadded paper, or ice from their drinks for nickels, Thomas Hood MacDonald, successor to the frustrated Tainter at the graphophone factory, applied for a patent on a more discerning machine at the end of 1892. Tainter, now consulting, filed his own patent for a coin-operated graphophone in April 1893 which he exhibited for the company at the Columbian Exposition later that year.[82]

Columbia continued to expand and profit from its repertoire, selling 300-500 cylinders a day in 1892-93. By the end of 1893 Easton had moved the company into a larger building on Pennsylvania Avenue in the District of

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[80]Brooks, "A Directory," 102, 103-104. Most soloists worked in front of three phonographs because of the physical difficulty of singing loudly into more: Gelatt, 49. Dan W. Quinn, probably the most prolific recording artist of the 1890s, was strong enough to sing into five horns for up to seventy-four two-minute songs in one day: Ulysses Walsh, "Reminiscences of Dan W. Quinn," Music Lovers' Guide, July 1934, 325, 326.

[81]R. Wile, "Record Piracy," 22; Koenigsberg, xxxii.

[82]Brooks, "Columbia Records," 10; Koenigsberg, xxxiv-v, xxxix, 63.

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Columbia. He installed a brightly lighted phonograph parlor with at a hundred machines, whose receipts covered the rental of the entire office.[83]

All this time the heirs to the Volta patents kept their eyes on the prize of phonography, the commercialization of one format in which they shared control. Aware of the ambiguities of the patent rights held by them and Edison, they had extended offers of alliance while retaining for American Graphophone a five-year option with Lippincott to buy his company and, with it, Edison's patents. Lippincott, contractually obligated to buy five thousand graphophones a year from the company, was more than willing. As the expiration date neared, however, Graphophone was unable to execute the option. Between January 1891 and June 1893, the company sold and leased its products for a total of $2,500 on expenses of $75,000.[84] Tainter's exposition graphophone represented the last gasp of Volta technology, for it and its listening tubes paled in practical operation before Edison's household phonograph which was also on display.[85]

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[83]Gelatt, 49; Brooks, "Columbia Records," 17-18; Moore, 9.

[84]Conot, 313; Fabrizio, "The Graphophone," 5, 9; R. Wile, "Growing Hostilities," 14.

[85]Gaisberg, 5-6. The graphophone continued to persist in the pages of the Sears, Roebuck & Co. catalog, which advertised a twenty dollar coin-slot graphophone in 1898: see page reproduced in Cynthia Hoover, Music Machines American Style: A Catalog of the Exhibition, introductory notes by Erik Barnouw and Irving Kolodin (Washington, D. C.: 1971), 42.

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In May 1893, however, Easton moved from the manufacturer's board of directors to its presidency and initiated a series of maneuvers designed to unify the Volta-based companies and establish their products as the only legal ones in the marketplace. Over the next two years, in order to unify management of the Volta system, Easton led a group of Columbia shareholders to buy out the interests of those who held stock only in American Graphophone. Together with fellow lawyer Philip Mauro, he launched a series of patent infringement suits against local companies to establish the primacy of the Volta patents. That accomplished, Easton could use the precedent to attack Edison himself. Finally, with that legal protection, he arranged for the conversion of the Bridgeport works into a factory for the production of phonographs and Edison wax cylinders.[86]

It was a brilliant strategy, one that exploited Edison's rationale for infringing on the Volta patents in the first place, particularly Tainter's specification for engraving rather than indenting the record. Even before Easton assumed formal control, MacDonald had started adapting the stock of graphophones to Edison cylinders, using at least four of the inventor's patented innovations. Easton began by having American Graphophone sue Columbia for handling North American's phonograph. Arguing that

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[86]Read and Welch state that Easton became president on May 1, 1893, 59-60; Fabrizio, "The Graphophone," 9, writes that he was elected vice president on April 10, became general manager shortly thereafter, and assumed the presidency in an internal coup in 1895.

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Edison's consent to paying a royalty on the phonograph and his refusal to display graphophone patent dates on his phonographs represented his admission of Volta's priority, American Graphophone won the case in 1894.[87] Meanwhile, less than a month after Easton assumed control, a Graphophone agent approached a former Edison employee and arranged with him to replicate the chemical formula for Edison's cylinders. A little over a year later, Columbia was able to record on and sell Edison-style cylinders made by its corporate partner.[88]

None of this was calculated to please Edison. In addition, Jesse Lippincott's death on April 18, 1894, raised questions about Edison's relationship with the North American Phonograph Company.[89] He had been president for three years after Lippincott's default, and he remained the company's biggest creditor. Almost simultaneously, American Graphophone won its case against Columbia and North American. This enabled Easton to incorporate the Columbia Phonograph Company,

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[87]Read and Welch, 59-60; Fabrizio, "The Graphophone," 9-10.

[88]R. Wile, "Cylinder Record Materials," 165; Brooks, "Columbia Records," 20; Shambarger, "Cylinder Records," 149.

[89]Conot claims Lippincott died in mid-1891, 311; Read and Welch give a specific date and place, 57, 60.

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General, in May for the marketing and distribution of American Graphophone's products outside of the original Columbia territory.[90]

Edison responded immediately. Unwilling to share the new home model, market with Columbia, or continue paying Columbia ten dollars royalty for every phonograph sold, Edison told North American's board that he wanted to resign the presidency. Then he put the company into receivership. Distracted perhaps by the success of the kinetoscope that summer and the ongoing ore separation project, Edison took three months to finally call in payment on North American's bonds on August 6, 1894.[91] Now that Edison had the opportunity to regain the rights to his patents and market his products without the local companies or any obligation to the Volta interests, American Graphophone sued him for infringement of the Bell-Tainter patents through his association with the array of companies that manufactured, distributed, marketed, or sold phonographs and cylinders. The combination of receivership and legal conflicts kept Edison out of the phonograph business until 1896. Two years was a long time to abandon an industry in a time of technological and commercial ferment, in the course of which not only Columbia but another rival established themselves.

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[90]Brooks, "Columbia Records," 20.

[91]Conot, 313-14.

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Section VIII: Emile Berliner Invents the Gramophone, 1887-1890

As popular as the phonograph became over the course of the 1890s, it remained a poorly adapted technology for sound reproduction, especially in the home. Until someone overcame the intrinsically contradictory demands that it act as medium for recording and reproduction, the limitations of the phonograph record would determine who could perform by virtue of their vocal traits and capacity for repetition, or who would perform despite the limited quality of the reproduction.[92] Broader expansion of the new industry would not take place until consumers, not producers, could choose what to hear.

The answer lay in making a master mold of the recording and from the mold producing in a more durable material as many copies as desired. The first inventors of the system had not overlooked the utility of this process. In early 1890, Alexander Bell roused himself from an inventive torpor to try making copies of a cylinder recording, but he could not remove the copies from the mold cleanly with any consistency.[93] Edison applied for a molding patent in 1888 and made some experimental molded records in 1889-90,[94] but his commitment for much of the 1890s to other system

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[92]Seifert, "Aesthetics," 430-31.

[93]Bruce, 357.

[94]Read and Welch, 51-52; U. S. Patent no. 484,582, in Koenigsberg, 6; R. Wile, "Record Piracy," 20.

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inventions offering greater profit limited his interest in reducing the cost of cylinder production.

The phonograph record thus remained an orphan technology in the early 1890s. After fifteen years, it had exhausted its novelty value; it was not practical either for business dictation or children's toys. It remained to another immigrant to direct the record toward home entertainment with a new format at a time when competition was limited to small companies. In doing so, Emile Berliner offered a different sound as well.

Berliner was not a particularly creative or original inventor. He appears to have based much of his work on the carbon button transmitter for the telephone on the work of contemporary inventors, and he took pains early in his career in phonography to acknowledge his debt to those who preceded him in thinking about and developing the technology.[95] He did not have a better or more definite idea for the use of the sound recordings than those who had been searching for a market before him. Yet this German Jewish immigrant established the format of the twentieth-century phonograph record as well as most of the basic principles of record manufacturing. Edison's and the Volta patents shaped the direction Berliner took, leading to his experiments with etching, which

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[95]Read and Welch, 121; Frederic Wile, Emile Berliner: Maker of the Microphone (New York: 1974 [1926]), 185, 207; Raymond R. Wile, "Etching the Human Voice: The Berliner Invention of the Gramophone," ARSC Journal 21, no. 1 (Spring 1990): 10.

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complemented his interest in developing mass production techniques. As with his work on the telephone, Berliner's approach to sound reproduction improved on the loudness of the sound reproduced. This focus mixed with research on mass production techniques and fed back further demands for clarity of reproduction.

Like other determined inventors, he persisted with his pet project in the face of consistent disinterest by investors or consumers for nearly ten years. Berliner was not well connected socially or industrially in the U. S., despite his work for the Bell telephone interests. Through a blend of his persistence, his connections in the German immigrant community, and opportunistic serendipity, however, Berliner found others willing to invest their time, thought, and money in making the gramophone a successful commercial product.

Emile Berliner became interested in the mechanics of sound recording and reproduction through work on the telephone just as Edison and Bell had. After emigrating from Germany in 1870 at the age of nineteen, he alternated between postions as a dry-goods clerk, travelling salesman, and laboratory assistant. A stint in the latter position under Konstantin Fahlberg, discoverer of saccharin, piqued Berliner's interest in the sciences. In the mid-1870s, he studied chemistry and physics in the Cooper Union Institute library in New York City. He became devoted to Johann Mueller's Synopsis of Physics and Meteorology, especially the

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sections on electricity and acoustics.[96] The practical combination of these fields offered considerable opportunity for a young man seeking to make his mark in cutting-edge technologies. By 1877 Berliner developed an improved telephone transmitter. In this he worked around Bell's patented telephone by using a direct current to carry soundwaves, rather than using soundwaves to generate a current. Bell's phone, according to Berliner's biographer, "was simply a good receiver," for it converted electrical energy to acoustic energy more effectively than the other way around. Speakers had to shout or bite the mouthpiece with no guarantee that their sounds would be effectively converted into electricity and then made recognizable on the other end. In April 1877 when he filed a caveat, Berliner was already matching Bell's phone in performance: the women in his boarding house "recognized my voice, and got familiar sentences now and then."[97] By the fall he applied for a patent on a transformer that improved the connection between transmitter and receiver as well as the dynamic range, the difference between the quietest and loudest sounds, on the listener's end.

Berliner sold the patents to the Bell Telephone Company, which hired him as a consultant on the commercialization of his devices. Here he found that more work was needed to realize his patents in production. The

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[96]Information in this and succeeding paragraphs comes from F. Wile, 18, 22-23, 25, 28-31, 34-41, 68-132, 155-67, 183-85.

[97]Berliner's testimony from "United States of America v. American Bell Company and Emile Berliner," quoted in F. Wile, 85.

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Bell phones still suffered from erratic transmission and a "boomy" tone such that "it took a trained man . . . to make commercial talking possible."[98]

Berliner resolved these problems, personally inspecting the first twenty thousand transmitters to ensure that they maintained their superiority to the Edison transmitter used by Western Union. In November 1882 he moved his family to Germany to establish the Bell telephone there and returned a year later to a new home in Washington, D.C.[99] There, like Bell, Berliner set up his own laboratory where he renewed his service contract with the company for two years before severing his formal ties. By the end of 1885, Berliner had made signal contributions to the invention and innovation of the Bell company's telephone and enjoyed a financial security rivalling that of Bell himself. He could afford to try developing patentable inventions which he could license or sell to the telephone company. Over the next fifteen months Berliner worked independently on a number of inventions for improved telephony, mostly on a carbon battery for long-distance transmission.[100] These apparently did not prove especially

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[98]Emile Berliner, "Final Development of the Blake Transmitter," in F. Wile, Appendix II, 315.

[99]Ibid., 183-5. Raymond R. Wile dates Berliner's return to D. C. as 1884 in "Etching," 3.

[100]The following are all in the AT&T Archives, Warren, NJ: Emile Berliner Contracts, 1881-2, 1884, Corporate Collection 133 10 02 14; Emile Berliner Service Contract, 1885, Corporate Collection 133 10 02 15; Emile Berliner Reports on the Transmitter, Cable Lines vs. Overhead Lines, etc.

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useful, and in the spring of 1887 Berliner turned his attentions to phonograph technology.

This was not surprising given his technical interests and his familiarity with the tribulations of Edison's phonograph business. Between November 1878 and February 1879, Berliner worked at the Bell headquarters in New York, which shared a loft with the Edison Speaking Phonograph Company, then falling into obscurity as Edison took up the problem of electric light.[101] Moreover, his association and lifelong friendship with Bell made it more than likely that he knew of the activities at the Volta Laboratory in the early 1880s.[102]

Nonetheless, Berliner did not apparently start working seriously on recording and reproduction until after the Volta group demonstrated the graphophone in May 1886. He began by studying the quality of sound produced by the Edison and Volta cylinders, where he noted that "the louder it was necessary to speak when recording, the less distinct became the articulation of the recorded sound."[103] Berliner believed that the changing

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1885-86, Corporate Collection 134 07 01 16; Emile Berliner Inventions and Experiments, 1885-86, Corporate Collection 134 07 01 22; Emile Berliner Battery for Long Distance Transmitter, 1886-7, Corporate Collection 134 07 01 05.

[101]Berliner, "Final Development," in F. Wile, 314-15.

[102]F. Wile, 157, 158; Bruce, 296-97, 488, 495.

[103]Quoted in R. Wile, "Etching," 4.

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force of soundwaves was insufficient to drive the stylus to the appropriate proportional depths in the cylinder wax or tinfoil. Thus, he concluded, better reproduction would arise from lateral recording--the stylus cutting a groove of even depth parallel to the record's surface--against the least resistance possible.[104]

How was Berliner to accomplish lateral recording and reproduction without indenting or engraving the groove? Leon Scott's phonautograph provided the template for Berliner's initial attempts to realize his conception. Scott's patent for sound tracing had long since expired, and Berliner could use that form of recording as a stepping stone to a novel form of reproduction. He built his own version and recorded his voice on a soot-covered piece of paper wrapped around the cylinder. Berliner based his methods for reproduction on the French poet Charles Cros's ideas, published and patented in France in 1877 and 1878. Berliner had the recording photoengraved and the lines etched onto a zinc plate. Much like Edison nine years before, he ran a stylus connected to a diaphragm and a horn along the etched groove and "got snatches of articulation."[105]

Berliner's patent lawyer found these noises "very much louder" than those from cylinder formats; he drew up and filed the application for the "gramophone" on May 4, 1887. On May 17, Berliner "succeeded for the first

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[104]F. Wile, 187-88; Berliner quoted in R. Wile, "Etching," 4.

[105]Koenigsberg, xxiv; F. Wile, 189.

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time to get [sic] an articulate speech, plainly audible" from what he called a "phonautogram."[106] Before the end of the month he had switched to disc recording, not for sound quality, but because the process of reducing a cylinder groove to an etching in two dimensions for a playing time of any duration was impractical.

Berliner tried to solve the problem of removing the soot turned up by the stylus by turning the platter and disc upside down. He worked initially with glass and glazed china discs and continued to experiment with recording material over the summer. Because the grainy nature of lampblack soot resulted in "ragged" high-frequency tracings, Berliner tested heated rosin dust and moistened plaster of paris before settling on a purer form of soot compounded with an oil. Now the stylus made a clean tracing of the soundwaves, even when viewed through a microscope.[107]

Having mastered the recording process, Berliner then turned to the challenge of developing an effective method of turning the recording into a record. Although Cros had pointed out the method of photoengraving, no one had yet separated successfully the processes of recording and

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[106]Quotes in R. Wile, "Etching," 4-5.

[107]Ibid., 5.

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reproduction.[108] This was Berliner's practical contribution to the development of the disc record, and he spent the summer and most of the fall making records of recordings. Borrowing liberally from Cros's patent, he first experimented with light-sensitive bichromated albumen to make positives which could then stamp the inverted grooves into sealing wax or plaster copies. Berliner had more success when he took a negative of the recording, exposed it to a glass or metal disc coated with the albumen, and then etched the spiral pattern with hydrofluoric or nitric acid.[109]

In November, Berliner received his "gramophone" patent and began publicizing his approach with a letter of announcement and an article in Electrical World. The reporter described an eleven-inch glass disc driven by a falling weight, where a governor regulated the speed of rotation. Berliner could record a four-minute message, and he looked forward to doubling the time. The phonoautogram was "practically indestructible," the inventor having played one a thousand times "without altering its character in the least." As to the quality of sound, "even at this early stage . . . a recognition of the voice is unmistakable." At a time when neither Edison nor the Volta group had profited from their systems, Berliner set no limits on the potential uses of his, which was "destined to fulfill many of the expectations

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[108]Michael J. Biel, "The Making and Use of Recordings in Broadcasting Before 1936," (Ph.D. diss., Northwestern University, 1977), 51-53; Koenigsberg, xxiv-xxv.

[109]R. Wile, "Etching," 6-7, n. 18.

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which were placed 10 years ago on the phonograph and which are partially realized by the graphophone." The reporter, however, looked forward to the discovery of the best material for making "the reproducing plate," anticipating the consumer's "choice of phonautograms recorded by popular orators, writers, singers, actors, etc." that music machines could not provide.[110]

Berliner pressed on over the winter, hampered by a move of his lab to downtown Washington and by a hired mechanic who was not as experimentally skilled as he had hoped. In February he simplified the process by recording right side up on a zinc plate coated twice over with a 16:1 solution of benzene and beeswax. After the benzene evaporated, Berliner had a thin, gravity-levelled layer of wax, which the stylus removed during the recording. Then he poured an acid on the disc to etch the exposed groove in the plate.[111]

After receiving a non-binding ruling from the Patent Office that Cros had not anticipated this approach, Berliner filed for a patent in March 1888.[112] Etching avoided infringement on Tainter's work for Volta, as the removal of the wax by the stylus did not represent the actual recording.

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[110]Seifert, "Aesthetics," 426; quotes in R. Wile, "Etching," 7.

[111]F. Wile, 196-97; R. Wile, "Etching," 8-9, gives much the same account based on three earlier sources.

[112]Koenigsberg, xxiv, xxxvii.

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Rather, it only guided the acid to the groove, where it would etch a new groove in the zinc. But the process revived old technical difficulties and raised new ones. Berliner resolved the damage caused by scrap wax and dust on the recording by mounting an alcohol drip over the disc. The alcohol lubricated the stylus and floated the scrap off the surface. He also struggled to maintain a constant depth of etching, since vertical variation in the acid's reaction with the zinc added noise to the recorded sound. Berliner never quite resolved this problem, as some records "were excellent, while others displayed peculiar defects, for the appearance of which no theory seemed to give an adequate solution."[113]

Berliner had not finished, for he wanted to mass-produce copies of his master record. At the same time, however, he was competing with Edison's promotion of the improved phonograph and accounts of the business plans of the graphophone interests. Having made the initial announcement of his work in November, Berliner found himself pressured by the Franklin Institute to make a presentation. On May 16, 1888, Berliner showed off the gramophone to 399 attendees in Philadelphia. He recorded and etched songs and sentences, letting the acid do its work while he continued to lecture. He played some pre-recorded discs, which were "loud enough to be distinctly audible all over the lecture room. The music could

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[113]Joseph Lyons, Berliner's patent attorney, quoted in R. Wile, "Etching," 9.

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be recognized easily; while speech . . . was for the most part intelligible."[114] Berliner explained that the harder the record material, the louder the sound, but the frictional noise "is also increased unless the record surface is smooth." His recordings that night made this apparent, for only with repeated playings did the stylus wear down the roughened walls of the grooves.[115] He spoke hopefully of discussions with a glass tile company about pressing a negative matrix into red-hot glass, but for now Berliner was frustrated at having to demonstrate a technology still in development. He promised one of his hosts that he would finish the gramophone in the next month.[116]

He found an answer for sound quality within two weeks. Berliner decided that the alcohol might be reacting with the wax; to retain its utility, he limited the application only to the area under the stylus and rinsed the disc with water after recording. He also increased the turntable speed from thirty to sixty revolutions per minute and substituted a funnel "whose fundamental resonance is below the average human voice." Now, he claimed, the "reproduction is . . . perfectly clear of other sounds. . . . Articulation is perfect and loudness unimpaired!" In the first claims for

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[114]Franklin Institute Minute Book for 16 May 1888, quoted in ibid., 10.

[115]Berliner quoted in ibid., 11; Read and Welch, 122.

[116]R. Wile, "Etching," 11.

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proven fidelity, Berliner's biographer related how the inventor's father-in-law mistook a record for Berliner's voice, and how a Spanish visitor was smitten by hearing a coloratura soprano on disc.[117]

Berliner still had to attain the mass production of his records, however, and this required two more accomplishments. He needed to develop an effective method of making a negative matrix of the etched zinc disc, and he needed to find a record material far more resistant to the stylus. For an effective rival to the cylinder, factors other than cost were minimal at this stage. Playing time on the cylinders amounted to about two minutes, which would not be difficult to match on a disc record rotating at a slower speed. The wax cylinders might sound better, but opera stars like the soprano Adelina Patti, so often invoked as a reason to pursue the development of the technology, had not shown any interest in recording.[118] No individual whose reputation rested on the aesthetic quality and purity of her or his voice could afford to waste it in endless recording for the bowdlerized form offered by the phonograph.

Berliner had a distinct advantage in one area: loudness. Cylinder systems generated low volumes for two reasons. In reproduction, because too much pressure on the wax grooves distorted them, Tainter and Edison

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[117]Berliner quoted in ibid., 12; Raymond R. Wile dates the claims in F. Wile, 198, from this period.

[118]Gelatt, 55; Seifert, "Aesthetics," 431.

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designed their styluses to impart as little force as possible. For the same reason they used a feedscrew, not the spiraling groove, to move the stylus and soundbox along the record. This prevented much of the force driving the cylinder from being imparted to the stylus and soundbox containing the diaphragm. Wax engraving permitted a more precise rendition of the soundwaves hitting the diaphragm than zinc etching, but playback in wax reduced the volume of all sounds compared to that in zinc.

Berliner described in August 1888 how, in playing back his masters, the metal groove resisted deformity in playback.[119] Both the force of the stylus and soundbox, and that of the motor propelling the record, could be applied to the stylus and diaphragm. The gramophone might lack the frequency range of the phonograph, but it would compensate in loudness and dynamic range. These qualities obscured the surface noise and freed the listener of the cumbersome earphones needed to hear the sounds on the cylinders.

To replace the earphones, Berliner's assistant, mechanic Werner Suess, mounted a horn on the tonearm holding the stylus and diaphragm.[120] Even with a counterweight for the horn, the stylus concentrated intense pressure on the record. Here arose the issue of record

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[119]Koenigsberg, xxxvii; R. Wile, "Etching," 13.

[120]U. S. Patent no. 427,279, filed August 6, 1889, and assigned to Berliner; see Koenigsberg, xxix.

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material, the rock on which the cylinder industrialists foundered throughout the 1890s.

The problem was that no natural substance appeared to fill the varied requirements necessary for a mass-produced record–at least, not at a price that justified its purchase by the general consumer. Sealing wax, an obvious candidate for filling precisely the fine grooves of a mold, either shrank and distorted in cooling, or was too soft to resist the force of the stylus. Between May and August, Berliner gravitated from glass to the first plastic. He and John Wesley Hyatt, the inventor of celluloid, collaborated on methods of plating the zinc disc and pressing celluloid records from the matrix. The first plastic record retained its proportions in cooling and added minimal surface noise in playback, but wore quickly under the weight of the reproducing arm.[121] Berliner returned to glass, but it stuck to the copper matrix he electroplated on the zinc record.

By the summer of 1889, however, Berliner had added through electrolysis a layer of iron to the face of the copper matrix. This mold was hard enough for the India Rubber Comb Company in New York City to stamp out a few copies of the zinc original.[122] There is apparently no description of the sound quality, but in the fall the inventor packed up his family, recording equipment, a gramophone, and several etched-zinc

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[121]R. Wile, "Etching," 12-13.

[122]Ibid., 14.

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records for Germany. After he divided his basic patent of May 1887 the Patent Office had declared the second part, filed that November, in interference. Great Britain and Germany, however, had declared his work valid. In his native land Berliner could commercialize his invention with the support of his family and friends in the telephone business he had established in 1881. He could also gain more publicity in exhibiting before various scientific societies, which in turn would aid his sales pitch to prospective manufacturers.[123]

Berliner accomplished all that he set out to do. His scientific presentations culminated in one at the Electro-Technical Society in Berlin on November 26, where he debated Werner von Siemens on the relative merits of Edison's wax cylinder and his zinc disc. As Berliner was still working on the consistent plating of matrices and pressing of plastic records, the zinc disc remained the best-practice example for demonstrations. Siemens acknowledged its durability, but was more restrained about sound quality. Berliner's technique "made it possible, if not probable" that discs would supercede cylinders in reproducing the tones of the voice, but for the present Siemens felt compelled to highlight the "essential purity of the Edison phonograph." Berliner could only respond that when the Edison player "reproduces loudly, its tones are not natural."[124]

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[123]Ibid., 14-15; F. Wile, 202-203.

[124]F. Wile, 205; quotes on 208, 209.

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Section IX: Innovating the Gramophone, 1890-1894

While press dispatches to the United States asserted Berliner's triumph over Edison in this comparison, Berliner was in no position to overstate his case.[125] He did not have a commercial product, and Edison did. Within a few days he engaged a large electrotyping company to make matricing, "at best an exceedingly delicate piece of work," a more consistent process. By early February 1890, his liaison, Louis Rosenthal, declared that he had worked out a system from which the company could "make about 400 or 500 plates . . . that would hardly be distinguishable from the original."[126] Berliner organized his business at last in July with Rosenthal's zinc copies, a contract with the India Rubber Comb Company's counterpart--the Rheinische Gummi- und Celluloid Fabrik Wërke--to produce hard rubber and celluloid records, and another with Kämmer und Reinhardt to manufacture gramophones and talking dolls. The discs were small: eight centimeters for the doll and 12.5 centimeters, or just under five inches, for the hand-powered gramophone.[127] The novelty of the European records

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[125]Ibid., 210-11.

[126]Quotes from Berliner and Rosenthal in R. Wile, "Etching," 16, 15.

[127]Ibid., 15-16; James R. Smart, "Emile Berliner and Nineteenth-Century Disc Recordings," in Iris Newsom, ed. Wonderful Inventions: Motion Pictures, Broadcasting, and Recorded Sound at the Library of Congress (Washington, D.C.: 1985), 350; Robert Friedel, Pioneer Plastic: The Making and Selling of Celluloid (Madison, Wis.: 1983), 70.

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faded in a few years much like Edison's earliest ventures, but Berliner returned to the United States in November 1890 with a claim of industrial plausibility with which to attract investors.

That was not enough, however, and Berliner had other legal and technical concerns as well. He demonstrated his improvements at a meeting of the American Institute of Electrical Engineers in December where, if no one was fooled by the fidelity, the assemblage "applauded the singers . . . as heartily as though they had been present."[128] Berliner tried to sell the gramophone to Jesse Lippincott, but the favorable review was not sufficient to convince the struggling capitalist to market the device through his network of cylinder lessees. Berliner finally incorporated the American Gramophone Company in April with a small group of New York businessmen who did little to promote the system while the inventor labored in Washington.[129]

At a baser level, Berliner continued to refine his product. Collaboration with Philadelphia inventor Max Levy during 1892 led to nickel-plated copper matrices that improved on Rosenthal's techniques.[130]

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[128]New York Times, December 17, 1890, quoted in Paul Charosh, ed., Berliner Gramophone Records: American Issues, 1892-1900 (Westport, CT: 1995), xii.

[129]Raymond R. Wile, "The Launching of the Gramophone in America 1890-1896," ARSC Journal 24, no. 2 (Fall 1993): 176-77, n. 5; 178.

[130]F. Wile, 199-200; R. Wile, "Launching," 178.

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At the end of March he filed a gramophone patent with thirty-five claims, the most important of which covered the groove-propelled stylus.[131]

Berliner marketed this playback system for the next five years, and it therefore deserves some description. The gramophone consisted of a turntable, a series of wheels and belts to drive it, and a pivoted arm holding the stylus, soundbox containing the diaphragm, and amplifying horn. On the turntable one placed a seven-inch hard rubber disc, and cranked a drive wheel to 150 revolutions per minute (rpm). A figure-eight belt to another wheel and gearing reduced the speed to seventy rpm at the turntable, a speed ostensibly maintained by a flywheel, although the instruction manual gave few hints as to how one measured this. Then one cued the stylus, which rested in the groove at an oblique angle. The soundbox acted as an off-center join for the arms of a vee formed by the horn and the supporting arm extending to the pivot post. Berliner mounted the machine on a ten-inch by sixteen-inch baseboard and with all its parts exposed, it presented an ungainly and awkward appearance compared to cylinder phonographs, much less the roller organs; it certainly resembled nothing else in the home.

The flywheel notwithstanding, Berliner needed something better than hand power to drive the turntable. The weight-driven recording turntable offered an approximation of constant speed; variation in playback affected the pitch of the record's sound. Edison's batteries had already

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[131]U.S. Patent no. 534,543; see Koenigsberg, xxxvii.

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proven impractical for home or office use, but the mechanical alternative of a spring-wound motor proved difficult to manifest. Berliner commissioned a clockmaker in New York in 1891 to provide one, but it was not strong enough to maintain speed against the weight of the tonearm or over the radius of the disc. Moreover, vibrational noise transferred to the stylus through the spindle and record obscured the recording.[132]

In 1893, Berliner continued to struggle, aided only by the ageing Suess and a group of schoolboys hired through his teenaged nephew. He failed to gain further endorsement from the Franklin Institute after another demonstration in January, and in April he transferred his patent rights and applications to the newly chartered United States Gramophone Company. This he organized with three friends and relatives, having concluded that outside investors had less of an interest in supporting continued development costs.[133]

Nonetheless, Berliner's reputation swelled as he recorded various singers, musicians, whistlers, and comedians in the Washington area. In the world of small fees of nineteenth-century recording, it is not surprising that performers migrated from the Columbia Phonograph Company to Berliner's enterprise, and one of these, vaudevillian Billy Golden, brought a Columbia accompanist with him. Amused by Berliner's mannerisms and

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[132]R. Wile, "Etching," 17; Koenigsberg, xl.

[133]R. Wile, "Etching," 17; idem, "Launching," 179.

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apparently impressed by the qualities of the disc recordings, sixteen-year-old Fred Gaisberg left the more established firm to procure vocal talent for Berliner's demonstration discs. Using his contacts, Gaisberg recruited known phonograph baritones and tenors with "loud clear voices" as well as the less expensive "local talent secured from the beer-gardens and street corners."[134]

While Gaisberg built up a catalogue, Berliner moved his fledgling company from one location to another and developed products and a marketing campaign that reflected his uncertainty as to the surest way to success. Lacking an effective spring motor, he designed gramophones powered by battery or an "Incandescent Current Motor" as well as by hand.[135] Berliner proposed to sell machines and recording services for personal use or advertising. One promotional record spoke of its potential as a form of correspondence and more flippantly as a means of enforcing wedding proposals.[136] Handbills circulated to local merchants encouraged

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[134]Tim Brooks, "Columbia Records," 14; quoted in R. Wile, "Launching," 180.

[135]R. Wile, "Launching," 180. Edison tried a house-current, or "electric light" motor in 1890 with miserable results; not even the General Electric Company's engineers could make them work: Conot, 309.

[136]Charosh, xii-xiii, n. 8 These two records were catalogued as "recitations." Their numbers, 619Z and 637, indicate that Berliner still promoted private recordings well into 1895, for the January release sheet listed only numbers 600 and 602: Smart, "Emile Berliner," 352. In addition, the Z suffix indicates that this promotion was recorded a second time, either

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them to sell gramophones for which they could also commission musical recordings. The merchant was to give these away to gramophone customers who would hardly "refuse to listen to a fine song or concert piece . . . even if interrupted by the modest remark: 'Tartar's Baking Powder is the Best.'"[137] In all cases, Berliner, like Edison but for different reasons, failed to see a profitable market purely in the selling of records for playback in the home. Even as a talking machine, the gramophone failed to match the standard of the thousands of music machines in American homes. Nonetheless, by late 1894, that is where the inventor-producer placed his product, and that is how he stimulated the industry to move toward home entertainment.

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with a variation in script or because Berliner needed more copies than one stamper could provide: ibid., 353. Because of its promotional nature, the latter case seems likely.

[137]Quoted in R. Wile, "Launching," 180.

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Chapter 3: Eldridge Johnson and the Sound of the Talking Machine, 1894-1922

Section I: Introduction

Between 1894 and 1922, inventors, entrepreneurs, and consumers reconstructed the phonograph record as a primary form of entertainment in the households of the American middle class. This required negotiations between inventors, entrepreneurs, and consumers over how to make a commercial product--a relatively fragile wax cylinder and its relatively complex playback equipment--into a part of the average household, subject to the stresses of usage by far more people less trained in operating the system. Or it required similar efforts by participants in making a noisy, if loud, black rubber disc into something consumers found more valuable than music machines of equivalent price. Finally, to explain the eventual acceptance of Emile Berliner's disc and understand the process that led to the LP, we should consider the competition between the supporters of the two formats.

It is sometimes assumed that the disc appealed to consumers and triumphed in the marketplace simply because it was a more efficient medium and took up less space. This assumption ignores the advantages the cylinder enjoyed before the turn of the century. By 1900, inventors, entrepreneurs, performers, and consumers had developed considerable familiarity with the technology: where it needed improvement, how to manufacture them, how to record on them, and how to record on them. In

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addition, cylinders offered certain technical advantages in sound quality over Berliner's noisy discs if inventors could solve the mass-production problem. By all rights, that should have been the format consumers used. Why, then, did Berliner's disc, which faced technical, commercial, and legal obstacles for the first fifteen years of its existence, become the format of choice for inventors, entrepreneurs, and consumers?

The answer lies in the personalities and motivations of the men involved in the industry. Edison was a better inventor than entrepreneur and Columbia's Edward Easton was a better lawyer than entrepreneur. Only Eldridge Johnson had the temperament, skills, and motivation to reconstruct himself successfully. Berliner's hand-powered gramophone offered an inexpensive means of hearing recorded voices at home without an eartube when he first encountered it by chance. That, and the durability of the records, were the only advantages of the technology over cylinders and the music machines that reached the acme of their popularity around the turn of the century.

Berliner's player had already spurred first Columbia, and then Edison, to lower the cost of their machines. His production of records from an electrotyped matrix forced the cylinder producers to begin manufacturing their wax records pantographically. Their technical inability to separate the recording from the record until 1903 gave the entrepreneurs selling the disc record advantages in production and marketing until Johnson could

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improve the sound sufficiently to solicit the attention of a different set of performers and consumers.

This was important because until the 1900s most consumers based record purchases less on aesthetic content or price and more on sound preferences: loud and scratchy, or soft and smooth in tone. No company had an entertainer under exclusive contract. Neither cylinder nor disc yet produced a sound with which elite performers wanted to associate for the fees offered. The performers of popular songs, marches, and vaudeville routines moved from one company and format to the next. Unrewarded by copyright or royalties, they were in some ways as anonymous as the players or programmers of the music machines.

When Johnson developed a reliable spring motor and decided to infringe on the Bell-Tainter patent by engraving in wax, he increased the clarity and consistency of the sound. He also positioned Berliner's disc system to dominate the market. Commercially, however, survival of the fittest depended on who could infringe on whom profitably without being infringed upon. The Berliner-Johnson interests had to navigate the challenges of Columbia's legal staff to their wax recordings and the efforts by their own sales arm and ex-employees to market their own disc systems.

By 1903, the competition among the three patent-holding concerns stabilized, largely because of the relative balance of power between them. This was not a matter only of market share or productive capacity. It

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depended also on the level of engagement of the proprietor with the technology, its marketing, and its consumers. Over the next twenty years, Johnson evolved from inventor-entrepreneur to captain of the industry as he, Edison, and Columbia each pursued different strategies of growth and innovation. Johnson led by reinvesting in the Victor Talking Machine Company's recording and manufacturing processes, which helped retain the celebrity high-culture performers who recorded exclusively for the record label. He also delegated responsibility for musical content, marketing, and production while retaining final approval in these areas and continuing to involve himself in innovations. Combined with a clever trademark and re-engineered gramophones that resembled furniture suitable for the sitting room, the records of Enrico Caruso and other opera stars gained Victor the prestige, market power, and increased profit margins that came from catering to the upwardly mobile middle-class.

The sound of Victor's records, spinning at seventy-eight revolutions per minute, had an unofficial trademark of needle "scratch" or "hiss" from the abrasion of the stylus by the mineral powder in the record. All accounts indicate that Edison's celluloid cylinders and "Diamond Discs" offered cleaner and truer reproduction than Victor's 78s. The sound of the record had improved since the era of wax cylinders, but, in the marketplace the greatest technical improvement lost out to the greatest singers in western culture. Edison never understood the value of celebrity in selling his

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records, but by the early 1920s, it became apparent in turn that Johnson never understood the appeal of the sound available from radios.

Section II: Introducing the Gramophone, 1894-1895

Despite his uncertain approach to marketing, Berliner always assumed that one application of his system would be in the home; he merely hoped that most people would use it to hear custom-recorded messages. On the other hand, both Edison and the Volta group, and their lessees, had long regarded their machines as commercial devices. That was the market they knew and that was the market best suited for the technology. In converting the phonograph from office dictation machine to jukebox, Edison and Columbia merely maximized use battery power, exploited the need for listening tubes in a public space, and kept the consumer's hands off the delicate cylinders and stylus mechanisms. When Edison and Easton prepared to enter the home market in 1893, the injunction against Edison and Columbia's pursuit of infringement cases against him and the local phonograph companies enabled Berliner to beat them to it.

In the fall of 1894, Berliner opened a factory and storefront at 109 North Charles Street in Baltimore, hired a manager to run them, and tested the home market.[1] His innovation centered around the Seven-Inch Hand

[1]Allen Koenigsberg, ed., The Patent History of the Phonograph, 1877-1912 (Brooklyn: 1990), xl; Raymond R. Wile, "The Launching of the Gramophone in America 1890-1896," ARSC Journal 24, no. 2 (Fall 1993): 181.

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Gramophone which, costing some two dollars to manufacture, sold for twelve dollars. The gramophone played two-minute "plates" at "about 70 revolutions per minute," and customers had forty-nine choices in the first catalog. The instruction manual did not explain how to ensure that one was turning the handle properly, but it advocated "a wrist movement, resting the elbow on the table." Record care was a greater concern, and the instructions encouraged owners to change needles regularly to avoid wear of the records. If new gramophone were unavailable, owners could regrind worn needles "to the rounded point of a darning needle. In fact, the broken-off end of darning needles ('Thorpes' No. 14) . . . are excellent substitutes [sic]."[2]

As ungainly and awkward as the gramophone appeared, it was far cheaper than a cylinder player. Columbia introduced a spring-driven graphophone for seventy-five dollars sometime in 1894. Despite the reliance on listening tubes, claimed the copywriter, it reproduced sound "as though the artists are present right in your living room."[3] Intended for the

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[2]Manual quoted in Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, 2d ed. (New York: 1965), 65-66; Koenigsberg, xl, lists a price of fifteen dollars for the gramophone. The term "plates" originated with Louis Rosenthal in Germany; see Chapter 2, n. 125. It should not necessarily be seen as part of a cultural identification of phonography with photography, given Rosenthal's work in electrotyping and electroplating. Records are still called "Schallplatten" in German today.

[3]Tim Brooks, "Columbia Records in the 1890's: Founding the Record Industry," ARSC Journal 10, no. 1 (1978): 20; quote in Charles Graham, "Jazz and the Phonograph," in Leonard G. Feather, The New Yearbook of Jazz

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home market, the graphophone cost half as much as jukebox models, but was still well beyond the means of most people considering investment in a new leisure activity.

The celluloid records also had multiple advantages over wax cylinders for home use. While they played for the same time, the discs were louder, easier to store, and the unrecorded center around the spindle hole gave space to identify the company, artist, and title. On the production cost of a dollar, they retailed for fifty cents apiece or five dollars a dozen. Cylinders cost one to two dollars apiece and would not gain labels--which hardly mattered inside a jukebox--until 1901.[4] Like Edison and Columbia, United States Gramophone announced new releases every month, and in the fall of 1894, sold some 1,000 machines and 25,000 records.[5]

(1958, reprinted in Feather, The Encyclopedia Yearbooks of Jazz (New York: 1993), 158 (page references are the same in both editions).

[4]The manufacturing cost of the gramophone and records are inferred from Berliner's October 1896 contract with Frank Seaman, in Raymond R. Wile, "The Gramophone Becomes a Success in America, 1896-1898," ARSC Journal 27, no. 2 (Fall 1996): 142-43; Brooks, "Columbia," 9.

[5]The numbers are from Berliner's 1898 affadavit in American Graphophone Company vs. the National Gramophone Company and Frank Seaman in Raymond R. Wile, "Berliner Sales Figures," ARSC Journal 11, nos. 2-3 (1979): 140. In later testimony in Victor Talking Machine Company and United States Gramophone Company vs. the American Graphophone Company, Berliner dropped the record sales to 1,000-2,000 and gave no total for players. Along with R. Wile, "Launching," 181, this narrative accepts the higher figure.

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No reliable figures exist for the next two years, during which time Berliner underwrote various technological improvements at the same time that he found himself caught up in a format war with the cylinder. For if investors found no sign of potential in gramophone sales in Baltimore and Washington, Easton and Edison did. In the next eighteen months both introduced cheaper cylinder players for the home.

Section III: The Need for Improvement, 1895

By the beginning of 1895, Berliner faced the usual challenges of a lone entrepreneur with a new technology. He had run down his savings from the Bell consultancy and patent sales, and his current income could not finance expansion. As Columbia and then Edison responded to his price advantage, he also needed to improve four aspects of his system. First, only a practiced operator could maintain an appropriate speed on the turntable. Second, the action of the acid on the zinc below the groove in the wax added noise to the recording. Third, Berliner still struggled with the matricing process, which took up to a week, went awry, which necessitated another recording.[6]

Finally, the records continued to cause problems. Berliner switched to "vulcanite," a brand of hard rubber, in April 1895 perhaps because it was cheaper than celluloid. If that was the case, he got what he paid for. The

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[6]Emile Berliner, "Matrix Making from a Zinc Etching," reproduced in Raymond R. Wile, "The Gramophone Becomes a Success in America, 1896-1898." ARSC Journal 27, no. 2 (Fall 1996): 142, 144, 146, 148, 150, 152.

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sulfur in the material corroded the metal matrices during pressing. Erratic quality control of the blend meant that the vulcanite often bubbled in places when heated, failed to fill all the grooves of the matrix, and warped when it cooled unevenly. These flaws, along with the coarseness of the material, meant that the proportion of noise to desired sound was little better than par.[7] The discs offered better resistance to wear than the wax cylinders, but the greater stylus pressure from the support arm and horn offset that advantage.[8]

Berliner needed capital and skilled technical help to overcome these obstacles to better sound at a competitive price, and he could not gain one without the other. Unlike Edison and Bell, however, he lacked the contacts. His arrival in the United States without family and his travels since then gave him no network of technically skilled or wealthy acquaintances; marriage did not change this state of affairs. The impracticality of his inventions since the microphone had worn out his welcome with the

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[7]An indicator of the sound quality of Berliner's records between 1990 and 1894 can be found in the first five tracks of Emile Berliner's Gramophone: The Earliest Discs, compact disc 1058, Symposium, 1988.

[8]Gelatt, 88; Oliver Read and Walter L. Welch, From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed. (Indianapolis: 1976), 127; Koenigsberg, xl. In the 1970s, an engineer described the loudness of the recording as six to seven decibels (db) above the noise level; vinyl, microgroove records at that time were capable of fifty-five to sixty decibels. This measurement system is logarithmic, not linear: Warren Rex Isom, "Record Materials, Part II: Evolution of the Disc Talking Machine," Journal of the Audio Engineering Society 25, no. 10/11 (October/November 1977): 719.

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Boston brahmins running the telephone company. Moreover, he assumed his vocation as inventor without sufficient theoretical or experimental training. Once he settled in Washington, D.C., like Bell, he made no contacts with the local machinist community, either because of anti-semitism or location. Berliner kept his lab in his house on the outer limits of the capital, far from the manufacturing precincts or the naval yard. His only assistant remained the far older immigrant, Werner Suess.

While Berliner oversaw the factory and business, then, he sent Gaisberg and a retired Methodist preacher named B. F. Kearns out in search of funding. They could not have made an impressive couple: a youthful-looking twenty-two-year-old and an elderly con man from Maryland's Eastern Shore who borrowed hundreds of dollars from Berliner and Gaisberg to keep his family, as he told his lenders, from subsisting on cheap liver. Kearns saw the future of the gramophone in talking dolls, which Berliner's accented demonstration disc of "Twinkle, Twinkle, Little Star" helped reinforce. But this approach got the pair laughed out of offices in Boston. Berliner had arranged meetings with directors of the Bell Telephone Company, whose experiences with investments in Edison's Talking Doll sparked only sarcastic comment on the gramophone's potential. A meeting with F. A. O. Schwarz, of New York's leading toy

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emporium, led to a similar if more gentle rebuff, and Berliner's emissaries returned literally penniless to the District in mid-February.[9]

Berliner struggled for the next six months as the novelty of his system wore off for both performers and customers. Monthly record releases declined in number from the twenty-five to thirty he had promised in January. This occurred in contrast to events at Columbia, which began recording John Philip Sousa's band in March and announced a standard cylinder price, following Berliner, of sixty cents, or six dollars a dozen. Nonetheless Berliner managed another demonstration at the Franklin Institute, and between this or Kearns's contacts he met William C. Jones, who signed an exclusive contract to make and deal in Berliner's inventions. A month later, on October 8, Jones organized the Berliner Gramophone Company with some investors in Philadelphia. They moved all but Berliner's electroplating operations to that city, leaving the inventor in Washington with a ten percent royalty agreement, $15,000 in advances against the first year's retail sales, and a $5,000 annual retainer.[10]

With only $25,000 in capital for the new company, Jones and Kearns concentrated on assembling the components from Berliner's old firm and selling off the remaining handwound gramophones. This became even

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[9]Gelatt, 67; R. Wile, "Launching," 181.

[10]Brooks, "Columbia Records," 21-22; Gelatt, 67-68; R. Wile, "Launching," 181-83.

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harder to accomplish as Columbia mounted a full-scale national magazine campaign directed at upper-middle-class families for its springwound phonographs and catalog of cylinders. The gramophone needed marketing help and in early February 1896 Frank Seaman, an advertising agent, contracted regional sales rights to his New York Gramophone Company. He too pressed Berliner for a spring motor, which the inventor had not produced by the time Gaisberg responded to an advertisement in the Philadelphia Public Ledger for clockwork motors.[11]

Section IV: The Search for a Spring Motor, 1895-1896

In any rational world, Gaisberg's visit to the machine shop of pattern makers George and Henry Whittaker on North 12th Street should have resulted in a straightforward outcome as to whether they could adapt one of their sewing machine motors to the gramophone's requirements. Instead, it led to a chain of contacts with men who went a long way to ensuring the dominance of Berliner's system in the twentieth century. To begin with, the Whittakers had yet to sell one of their motors, which was apparently oversized and underpowered. Nonetheless, they thought of someone who could make what Gaisberg sought, whereupon he left a gramophone and some discs with them. The Whittakers then contacted Belford G. Royal of

[11]Koenigsberg, xl; R. Wile, "Launching," 183-84.

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the Eldridge R. Johnson Manufacturing Company in Camden, New Jersey, directly across the Delaware River.[12]

Eldridge Reeves Johnson was just celebrating his twenty-ninth birthday on February 19, 1896. He grew up in southern Delaware on a farm and in the capital of Dover where his father earned a living as a carpenter. A descendant of declining gentry, Johnson attended Dover Academy with aspirations of going to college and regaining the status of his ancestors. Frustrated by unimaginative teachers, however, he did poorly. On his graduation in 1882, the headmaster told the fifteen-year-old he was "too Goddamned dumb to go to college. Go and learn a trade."[13]

His parents arranged for an apprenticeship with a jewelers' toolmaker in Philadelphia. Five years later, Johnson completed his training and joined a machine shop in Camden. He took over for the suddenly deceased heir-apparent and completed the invention of an automatic bookbinding machine. He and the owner partnered on the marketing of the binder, but a badly negotiated contract and the Depression of 1893 moved his partner to

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[12]Eldridge R. Johnson, "Memorandum for Guidance of Mr. Eyre Dictated from Memory and not Corrected," December 14, 1920, 1, courtesy Nicholas R. Pensiero; Eldridge Reeves Fenimore Johnson, His Master's Voice was Eldridge R. Johnson (Milford, Del.: 1974), 40; Koenigsberg, xl; R. Wile, "Launching," 184. The accounts of Johnson's connection with the Whittakers relies primarily on Johnson's memo which, along with the rest of Mr. Pensiero's collection, is now at the Hagley Museum and Library as Collection 2138, "Files of Nicholas F. Pensiero."

[13]E. R. F. Johnson, 22-27, quote on 27.

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sell out to Johnson the following year. For the next two years, the machinist labored to sell the binder while landing odd contracts with the city of Camden to make voting machines and with local inventors to develop a steam-powered bicycle.[14]

None of these sources of income offered any long-term prospects, and presumably Royal's return with a gramophone and some records from the Whittakers augured no differently. Henry Whittaker met with Johnson, explained the requirements, and left him the handpowered model as a basis for development. Johnson built and delivered a model based on Whittaker's ideas to the Berliner Company's directors in March, which proved to regulate the speed of the turntable no better than the handcrank.[15]

Yet Johnson saw something in the potential of the technology and its place in the small but growing market for recorded sound. He had heard Edison's tinfoil phonograph during a demonstration at Dover Academy, followed the development of wax recording and reproduction since then, and looked forward to the operation of this new development. Instead he was "greatly disappointed," for Berliner's system, "loud and simple" as it was, "sadly lack[ed] in articulation and true tone quality."

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[14]Ibid., 27-35.

[15]Koenigsberg, xl. The chronology of the motorization of the gramophone in 1896 relies primarily on the memories of three participants: Gaisberg, Johnson, and Alfred Clark. This account tries to resolve the confusion of chronology as recalled decades later.

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> It was difficult for the average person to turn the machine at an even speed by hand. The sound boxes or reproducing boxes were not constructed on proper lines. They would rattle and blast and the records were very scratchy and full of false tones. Many spoken words could not be reproduced and many musical tones could not be reproduced.[16]

In short, the gramophone "sounded much like a partially educated parrot with a sore throat and a cold in the head, but the little wheezy instrument caught my attention and held it fast and hard."[17] Whatever he thought of the system, however, Johnson was in no position to make all the necessary improvements. He had borrowed $5,400 to buy out his former partner and determined that he would not propose to his future wife until he could pay himself sixty dollars a week; this did not occur until 1897. Therefore he contracted to build two hundred motors, receiving an advance with which to expand his shop's facilities. Johnson added improvements in the course of production, the first of which was a governor based on his work with steam engines.[18]

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[16]E. Johnson, "Memorandum," 2.

[17]Eldridge R. Johnson, "The History of the Victor Talking Machine Company," typescript dated February 1913, p. 4, Sarnoff Corporation library vertical files, Princeton, New Jersey, and reprinted in Mrs. Eldridge Reeves Johnson, comp., Eldridge Reeves Johnson(1867-1945): Industrial Pioneer (1951); quoted in Gelatt, 84; B. L. Aldridge, The Victor Talking Machine Company, edited by Frederic Bayh (Camden, N.J.: 1964), Appendix XIV, 118; and E. R. F. Johnson, 40.

[18]Aldridge, 18; E. R. F. Johnson, 48; Koenigsberg, xli; R. Wile, "Launching," 185. His son suggests that Johnson proposed in the spring or early summer, but as he and Elsie Reeves Fenimore did not wed until

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A spring-wound gramophone was innovative enough to make the cover of the Scientific American in mid-May, but the reality was that Johnson's governor "didn't govern." Seaman advertised in the same issue for the hand-wound gramophones. By July, when William Barry Owen, Seaman's new sales manager, came to Philadelphia to inspect gramophone operations, it appears that the company and Johnson renegotiated the original agreement. Owen, company president Thomas Parvin, and Alfred Clark, manager of the Berliner store in Philadelphia, met with Johnson, who had already sounded out Levi Montross, another Camden machinist, about subcontracting motor manufacture using a design Montross was about to patent.[19]

During this meeting and those that followed, the businessmen and the machinist developed lifelong friendships, bonded by a complementary interest in making a particular technology into a high-quality and profitable system. That they were all gentlemen, or aspired to be, reinforced this bond and the way they approached the challenges of innovation. Johnson impressed the trio with his confidence and ability see beyond the technical details. He quizzed them about the size of an initial order and the logic

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October 5, 1897, that indicates an unseemly engagement of more than a year.

[19]Aldridge, 20; E. R. F. Johnson, 41-42; Koenigsberg, xlviii; R. Wile, "Launching," 185, and "The Gramophone," 145. Clark, whose recollections Johnson and Wile cite, confuses these meetings with one the following year, after Owen travelled to England to begin the gramophone business there.

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behind their estimates for follow-up orders if the motors worked as promised. Parvin, who had the most money invested, showed Johnson the Philadelphia factory and recording facilities. Given Berliner's lack of productivity, he had no one else to rely on for the technical improvements that would make the gramophone more than an expensive toy or novelty. He told Johnson "there was a big future for the business and begged me to interest myself in the development of the goods." Owen, as Seaman's agent, promised to order three thousand more motors, "if I would produce one that was satisfactory, that could be manufactured at a price that would enable them to sell them at a profit."[20]

On August 10, Johnson agreed to manufacture one hundred motors for Berliner Gramophone within sixty days.[21] He then turned to Montross for the motors to which Johnson would add the governor. Montross delivered the first motors at the end of September, completed delivery on October 15, and in between filed for a patent.[22]

Berliner at last had a motorized gramophone which, while still erratic in operation, sold quickly at $25, half the price of Columbia's cheapest

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[20]E. Johnson, "Memorandum," 2-3, quotes from 3; E. R. F. Johnson, 42; R. Wile, "Launching," 185.

[21]Aldridge, 20; Koenigsberg, xl; R. Wile, "Launching, 185.

[22]U. S. Patent no. 598,529; Aldridge, 20. Montross did not design his motor for the gramophone; the first six claims omit any reference to it: Koenigsberg, xxxix-xl.

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machine.[23] He also gained legal standing for his system. In July, nine years after he applied for it, he finally received the basic patent (U. S. Patent 564,586) for photoengraving a disc recording.[24] In October Berliner settled on an effective material for records. Recollecting an experiment with imitation hard rubber telephone receivers in the early 1880s and drawing on Gaisberg's investigations, Berliner contracted with the Duranoid Company of Newark, New Jersey, to try a similar substance for his discs. Duranoid workers attached Berliner's matrices to one of their button presses and set inside a blended, rolled biscuit of shellac, byritis, cotton flock, and carbon black. They closed the heated press and its plates on the biscuit, cooled them, and took out a disc. It was harder than rubber or celluloid, more resistant to wear, and louder in reproduction. Berliner had not overcome the intrinsic problem of the uncontrolled nature of acid etching, but for the time being, the smoothness of the shellac blend helped reduce the noise. All of these qualities offset the brittleness of the material.[25]

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[23]Gelatt, 86; R. Wile, "The Gramophone," 145.

[24]R. Wile, "The Gramophone," 143; Koenigsberg, 7.

[25]Frederic Wile, Emile Berliner: Maker of the Microphone (Indianapolis:, 1926; reprint, New York: 1974), 159-60; Read and Welch, 127-28; R. Wile, "Launching," 186; James R. Smart, "Emile Berliner and Nineteenth-Century Disc Recordings," in Iris Newsom, ed. Wonderful Inventions: Motion Pictures, Broadcasting, and Recorded Sound at the Library of Congress (Washington, D.C.: 1985), 354.

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The combination of new records and an effective motor led to another demonstration at the Franklin Institute, where a committee, after some debate, awarded Berliner the John Scott Legacy Medal. The improvements also gained favorable comment in the new trade journal, The Phonoscope. As a result, Gaisberg recruited Calvin Child, Columbia's record producer, and signed more reputable performers, to the Berliner recording laboratories.[26]

Section V: The Entrepreneurs Take Control, 1896-1897

Edison and Easton had not sat idly by while the disc entrepreneurs worked to gain popular acceptance of their system. Edison purchased the assets of the North American Phonograph Company in February 1896, organized the National Phonograph Company the following month, and rolled out his forty-dollar spring-powered phonograph at long last in April. Perhaps most importantly, it featured a horn.[27] Columbia responded with an infringement suit and a spring-wound graphophone in November that matched the new gramophone in price. Unlike its competition, the Columbia still relied on listening tubes, but customers could also choose records now priced to match Berliner's discs from a fifteen-page catalog. Throughout the year Easton opened new sales outlets while seven other

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[26]Gelatt, 87-88; R. Wile, "The Gramophone," 139-40, 147.

[27]Read and Welch, 62-63; Robert Conot, A Streak of Luck: The Life and Legend of Thomas Alva Edison (New York: 1979), 315-16; Koenigsberg, xlii.

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cylinder companies joined the competition.[28] In the middle of the December, Edison and Columbia signed a consent decree, acknowledging the validity of each other's patents, and arranged to cross-license their designs, clearing the path for a more direct competition between cylinder and disc.[29]

Meanwhile, Berliner was losing control of his invention through the incapacity of the Berliner Gramophone Company and his obsession with one aspect of the technology. He continued to focus on the mastering process in Washington, leaving it to Johnson and Clark to improve the soundbox and recording system.[30] As orders from Seaman for motorized machines rose through 1897 and Johnson expanded his plant to fill them, the machinist grew more interested in improving other components. The Berliner company, which should have handled further innovation, suffered financially from the demands of the payment schedule to Berliner, and lacked a "mechanical Superintendent of the right caliber."[31] Alfred Clark, nominally in charge of inspections, by this time had befriended Johnson such that the pair shared an apartment and collaborated on further

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[28]Read and Welch, 65-66; Brooks, "Columbia," 22-23.

[29]Read and Welch, 65; Conot, 316.

[30]Gelatt, 87; Clark added a governor to the hand-wound gramophone for field recording, U. S. Patent no. 597,875, and collaborated with Johnson on a better soundbox, U. S. Patent no. 624,625: Gelatt, 86; R. Wile, "The Gramophone," 145.

[31]Quote from Berliner in R. Wile, "The Gramophone," 143.

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improvements to Berliner's system. Close inspection of the listening tubes on the hand-wound gramophones, the consistency of the governors, or the linkages in the soundboxes were time-consuming and less important in the long run, to their minds, than improving production.[32]

This cycle reinforced Seaman's growing independence. Relentlessly confident and well dressed, this prototypical ad man had been hawking the hand-wound gramophones with two discs for fifteen dollars in the print media as the "Talking Machine That Talks Talk!"[33] On October 10, 1896, in return for forgiveness of advertising debts Seaman had incurred, the Berliner company granted Seaman a personal contract to sell the gramophone nationally, and the right to contract out manufacture of gramophones if the Philadelphia firm could not provide them. Nine days later Seaman and Owen organized the National Gramophone Company, which bought the Berliner contract from Seaman and ordered another six hundred motorized gramophones in December.[34]

Over the winter of 1896-97, thanks to vigorous advertising by the three leading companies and increased production of motorized record

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[32]R. Wile, "Launching," 186, and "The Gramophone," 143; E. R. F. Johnson, 42.

[33]Gelatt, 85-86, quote on 85; E. R. F. Johnson, 44.

[34]Koenigsberg, xl; R. Wile, "Launching," 186, and "The Gramophone," 140-42, 153.

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players, the record industry picked up steam in sales and competition. Between September 1896 and March 1897, Seaman paid $12,240 in royalties to Berliner Gramophone; over the next year, annual sales volume doubled. The suddenness of the demand appeared in his public apologies for the backlog of orders in March, and in his order for another 3,500 motors from Johnson and Montross.[35] Seaman also started complaining about the lack of quality control in December and continued to do so even as he sought cheaper motors in the face of competitive cylinder players. In August 1897 Columbia introduced the "Eagle," a ten-dollar graphophone. The Eagle promised to give as good sound as the $25 "Columbia," a policy Seaman thought "suicidal" unless the company expected to profit from increased cylinder sales. [36]

Seaman wanted to respond with an equally cheap gramophone, based on a smaller motor, which could also be applied to the "scheme goods" trade of promotional machines, and one for the jukebox trade.[37] Johnson's reaction suggests some of the cultural differences between the ad man and the gentleman. By October 1897 he had paid off his debt and married well

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[35]Gelatt, 86; Aldridge, 20; Smart, "Emile Berliner," 355; Koenigsberg, xl-xli.

[36]R. Wile, "Launching," 185, and "The Gramophone," 143, 145, 149, quote on 154.

[37]R. Wile, "The Gramophone," 154-55.

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while devoting himself to the manufacture of a better record player. Descending to the level of the lowest common denominator was no way to build a product or be a gentleman. Johnson rejected Seaman's requests for technical, commercial, and cultural reasons. He had experimented with a motorized feedscrew for a jukebox tonearm, but it complicated the device and diffused his focus on the middle-class home market. As for the cheaper machine, Johnson had other priorities.

Instead, he offered to make the hand-wound, Clark-governed "toy" gramophone, as all now regarded it, for $1.50, or fifty cents less than Berliner Gramophone charged Seaman. No one could confuse it in name, appearance, sound quality, or price with Johnson's Improved Gramophone, on which he filed a patent application in August. The toy served as an effective entry model for the $25 machine, which featured his and Clark's soundbox and his more reliably governed motor. Johnson added a third ball to the governor which effectively maintained a set speed through sustained musical notes. In his determination to make recorded sound a reputable industry, Johnson had the support of Parvin, who arranged to front capital for plant expansion and research. In return, Johnson assigned shares of two patents to Parvin personally.[38]

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[38]Ibid., 155, 159, 163; E. R. F. Johnson describes the governor, 43; Koenigsberg, xli.

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Johnson still complained by the end of the year that there had "been no improvement in the gramophone" since the summer and since Seaman's "sole object is to cheapen the manufacturing cost" there was little prospect for any in the future.[39] Indeed, Seaman's advertising suggested that his strength in promotion lay less in the quality than the novelty of the product. Prospective customers of a record player were urged to listen to "the Improved Gramophone, with its new sound box, new motor, and new records; it is positively and pre-eminently without a rival." Consumers agreed. The Improved Gramophone would not change for the next four years, during which Johnson built 44,550 motors to power the system.[40]

Section VI: Exploiting a Growing Market, 1897-1901

Johnson therefore devoted more of his time to recording research, since the record shared complicity in the sound of the sick parrot. Not more than a month after he delivered the Whittaker model to Philadelphia, Johnson described to his patent lawyer, Horace Pettit, the notion of recording a laterally cut wax disc, and then electrotyping a matrix from which multiple stampers could be produced. Because so much of Johnson's

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[39]Quoted in R. Wile, "The Gramophone," 155.

[40]Quote in Gelatt, 87; Edgar Hutto, Jr., "Emile Berliner, Eldridge Johnson, and the Victor Talking Machine Company," JAES 25, no. 10/11 (October/November 1977), 667; figure for motors and gramophones sold from R. Wile, "Sales Figures," 140-42. Koenigsberg, xli, estimates 32,000 machines, which perhaps accounts for handwound gramophones not specified in Wile's totals from court testimony.

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idea was based on Tainter's and Berliner's patents, Petit advised him to keep his research secret until the courts settled priorities on the earlier patents.[41]

Working with A. C. Middleton and Bentley Rinehart, Johnson began with candle wax molded in pie plates, on which he made test recordings with a jury-rigged gramophone. After considerable experimentation to make the wax of uniform consistency, he melted down Edison cylinders for his recording blanks. To test the effect of electrotyping on his recordings, Johnson took a pie-slice cut of a disc to Charles K. Haddon, a friend from their apprenticeship who now kept the books at a company with an electroplating department. First dusting the non-conductive wax with graphite powder, Johnson obtained a copper master of the record in September.[42]

Johnson did not follow up on his idea until he visited Berliner in Washington in January 1897 to discuss his other innovations and see how Berliner made recordings and matrices. The need to switch from etching to wax engraving was obvious once Johnson drew on his experiences with microscopes in making jewelers' tools: "the etched line looked very much like a photograph of the crater of a volcano." Johnson's own experiments with recording on zinc convinced him of the sensitivity of the stylus in the

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[41]Aldridge, 22; E. R. F. Johnson, 48.

[42]Johnson, "Memorandum," 6-7; Aldridge, 22; E. R. F. Johnson, 36, 47-48; Read and Welch, 128.

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recording process, and he devoted his time away from production to improving the record.[43]

The expansion of Johnson's plant, marriage, and his honeymoon in October 1897 delayed further research and development, but at the beginning of the new year Johnson hired William H. Nafey to render, under lock and key, his plans for the recorder.[44] Nafey completed the prototype in April, when Johnson electrotyped a recording and pressed a test disc. It "was not entirely up to my highest ideas [but] it was very clear and very loud. . . . equal to the Berliner etched record in volume."[45]

By the summer of the 1898, Johnson had overcome the "chief difficulty" of lateral recording on a wax master record: developing a an appropriate recording stylus. Aided again by his own experiences with small-scale engineering and Parvin's information on Berliner's techniques, Johnson developed tools for the standardized manufacture of an elliptical cutting head (U. S. Patent 778,975). He had also drawn up plans for a commercial soundbox and a recorder that would shave flat a wax disc.[46] On

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[43]E. R. F. Johnson, 45-46; quote from Johnson, "Memorandum," 3.

[44]Aldridge, 22; E. R. F. Johnson, 48.

[45]Quote from Johnson, "Memorandum," 8; Aldridge, 22; Read and Welch, 128.

[46]Johnson, "Memorandum," 6-7.

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August 16 Johnson filed applications for the cutting-head tools and for a record with elliptically shaped grooves of even depth (U. S. Patent 896,059).[47]

Up to this point, Johnson kept his work secret from the Berliner group. Word from Middleton and Clark, however, reached Parvin in the fall. The prospect of better sounding discs appealed to the director. Acid etching of records would never be as precise as engraving despite Berliner's devotion to his method. Moreover, it was only a matter of time before someone established a cost-effective method of matricing cylinders and molding harder records that would match the discs' loudness and surpass them in clarity. Enthused by the prospects of a significant improvement, Parvin offered to finance the cost of further development and asked Johnson to remaster the Berliner catalogue. He also proposed to buy the recording system for $3,000.[48]

Johnson was torn by the offer. He knew of the extent to which other patents anticipated his work. No one had contested Bell and Tainter's patent for cutting a sound wave in wax, which would expire in 1903. While it specified vertical engraving on a cylinder, it stated nothing specific about

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[47]Koenigsberg, 59.

[48]Johnson, "Memorandum," 9-10.

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lateral cutting. Nonetheless, its existence had deterred Berliner from anything more than lab experiments with wax disc recording.[49]

A more immediate concern lay in the latest patent application of former Berliner employee Joseph W. Jones. The teenaged son of the financier who organized the Berliner Gramophone Company, Jones was mechanically apt. In January 1897 he applied for a patent related to the toy gramophone (U. S. Patent 602,453) and for three more in May and July. Under no contract to the company, despite Berliner's warnings, Jones moved to New York with a co-worker linked to American Graphophone and joined in an effort to establish a rival disc system. On November 19, he filed an application for the "production of sound records," (U. S. Patent 688,739) that, like Johnson's earlier conception, steered between Berliner's lateral recording and Bell and Tainter's wax engraving. In June 1898, however, the patent office denied Jones's revised application.[50]

Johnson and Parvin consulted with Berliner, since Johnson's record relied on Berliner's basic claim for the guidance of the stylus by the groove walls and motion of the groove (U. S. patent 534,543). The claims for lateral

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[49]Aldridge, 22, 24-25, 28-29; Read and Welch, 128; R. Wile, "The Gramophone," 151; Raymond R. Wile, "The American Graphophone Company and the Columbia Phonograph Company Enter the Disc Record Business, 1897-1903." ARSC Journal 22, no. 2 (1991): 208.

[50]R. Wile, "The Gramophone," 163.

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recording on disc might also be relevant, and Johnson agreed to pay Berliner royalties if his claims stood up.[51]

Patent concerns concerns aside, Parvin's willingness to underwrite further research and development also helped mitigate Johnson's concerns. Johnson had established the recording system, but still needed to improve the plating process. In the first place, Berliner's matricing system did not work well with wax. In the second, commercial electrotyping, on which he had based his work, was designed for low-pressure printing presses. Records required more pressure than buttons to fill the grooves over a large surface area. In September, with Parvin's money, Johnson hired Bentley Rinehart, former client and inventor of a steam-powered bicycle, to resolve these drawbacks. Before typhoid disabled Rinehart that winter, he formulated a better record blank and improved the conductivity of the graphite dusted on the recording before electroplating.[52]

Johnson had a complete recording and electroplating system in place by March 1899. By then, however, the Berliner Gramophone Company was in no position to complete its contract for Johnson's recording system. It was still in debt and now embroiled in litigation with Seaman and American Graphophone. For while Johnson was taking the gramophone

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[51]R. Wile, "The Gramophone," 163; Aldridge, 24-25.

[52]Johnson, "Memorandum," 8-9; Aldridge, 22, 24. Johnson contracted out electrotyping of matrices to the Franklin Electrotype Company in Philadelphia: Aldridge, 103.

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far beyond anyone's technical expectations, Frank Seaman had struck out on his own in the marketplace. More importantly, Columbia's management had taken the gramophone's technical and commercial advances seriously enough to sue for patent infringement.

Seaman had good reason to go his own way, for the group in the Delaware River valley had regularly thwarted his efforts to build on his successes. A basic issue was profit margin, which Seaman found too slim for the effort and risks he took promoting Berliner's system. Seaman paid Emile Berliner a ten percent royalty on his retail sales and the Berliner Company forty percent of Johnson's price for manufacture, which was cost plus ten percent. The margins eroded as Columbia and Edison cut prices, and Seaman further discounted his prices to dealers.[53] Berliner Gramophone and Johnson received their money whether or not someone bought the machines and records; Seaman relied on actual sales for his profit.

Unable to get what he wanted from Parvin or Johnson--a cheaper motor, a slot-machine attachment, or a mark-up to Berliner that Seaman would kickback to the machinist--Seaman set about establishing new markets and independent sources of equipment and records. In the summer of 1897, with Berliner's permission, Seaman sent his sales manager, Owen, to England. Owen began with the premise of selling

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[53]Aldridge, 25-26.

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gramophones and records supplied by Seaman to someone buying the European rights to the system. Owen returned in July with Trevor Williams, a Lincoln's Inn solicitor, in tow. They visited Philadelphia and Camden, during which the men found a commonality of interests and realized that Seaman had sales rights only in the United States.[54]

Two weeks later, Owen resigned from National Gramophone's board and, back in England, began pressing Seaman and Owen's replacement, Orville La Dow, for promotional machines. In January 1898, juggling the interests of both markets and their managers, Berliner offered Seaman and the Berliner Company a dollar royalty per gramophone and fifty cents per dozen discs on an order from Owen for ten thousand machines and 600,000 records. Berliner took pains to convince Seaman of the easy profit in the arrangement, which would obviate "resorting to measures in Europe for manufacturing purpose." The inventor left it unclear whether he meant Seaman or himself. By April 1898 Williams purchased Berliner's European rights and organized The Gramophone Company, Ltd. He agreed to buy three thousand machines and 150,000 American discs directly from the Berliner Company, skipping Seaman entirely.[55]

In the fall of 1897 Seaman also took steps to procure sources of records. He persuaded Berliner to demonstrate his mastering technique in

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[54]R. Wile, "The Gramophone," 149; Aldridge, 26; E. R. F. Johnson, 41.

[55]R. Wile, "The Gramophone," 149, 156-57; quote on 157.

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Manhattan, Brooklyn, and Boston as a publicity stunt. This gave La Dow, who had previously prepared electrotyped ads for the Royal Baking Powder Company, an opportunity to observe Berliner's techniques and try to copy them. In December, Seaman arranged with recorder Calvin Child and an electrotyping firm to make experimental matrices from which he could press his own records.[56] Through a contact with George Burt of Milburn, New Jersey, Seaman also proposed a return to celluloid for records. Maker of billiard balls and poker chips, the Burt Company offered a cheaper record of greater durability when played with the improved gramophone, and Berliner recognized the merits of the material in some experimental pressings. But Parvin and the Philadelphia shareholders would not countenance a price below that of the Duranoid discs, for that would in turn lower the commission they received from La Dow and Seaman.[57]

For motors, Seaman turned to Montross, who offered a two-dollar model to be used in a ten-dollar promotional machine. Seaman submitted an order to the Berliner Company in October 1897 for two thousand of Montross's motors. Parvin agreed to use them whereupon Seaman and La Dow reorganized National and separated Seaman legally from its operation.

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[56]Raymond R. Wile, "Record Piracy: The Attempts of the Sound Recording Industry to Protect Itself against Unauthorized Copying, 1890-1978," ARSC Journal 17, no. 1-3 (1985): 27; R. Wile, "The Gramophone," 157, 169, and "American Graphophone," 210.

[57]R. Wile, "The Gramophone," 160.

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Shortly before Christmas, the company began advertising the "Vo-co-phone, the Improved Gram-o-phone," in the New York Sun. Over Parvin's continued protests, the "Zon-o-phone" replaced the Vo-co-phone in February 1898, Seaman explaining that consumer confusion over gramophones and graphophones necessitated the name change.[58] It took Johnson's threat to sue Montross in March over infringement of Johnson's governor restored the gramophone. In a settlement out of court, Montross fulfilled his contract and left the gramophone business, while Johnson stopped paying a motor royalty to Montross.[59]

Johnson's former partner was not, however, Seaman's only option. In February 1898 some Wall Street businessmen incorporated the Universal Talking Machine Company, Orville La Dow, president, for the administration of patents, manufacture of sound reproducing machines, and sale and licensing thereof. Seaman and La Dow started Universal specifically for the production of a gramophone adapted to the slot trade by a New Jersey inventor named Louis Valiquet. Valiquet had already applied for a patent for a music box motor, and Seaman saw in him another alternative to Johnson, one who would devise cheaper components for the gramophone in return for financial support. By July 1898, Parvin agreed to

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[58]Ibid., 153, 159.

[59]Aldridge, 20, 26; Koenigsberg, xl-xli; R. Wile, "The Gramophone," 154-55, 159.

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Seaman's use of Valiquet's design. On the other hand, he and Johnson refused to either manufacture Valiquet's cheaper version of the gramophone, or buy them from Universal.[60] Blocked by his suppliers from the low end of the American or any part of the British market, Seaman set up shop in Paris in the spring of 1898, selling his zonophone and counterfeit Berliner records. When Williams complained, Seaman replied that Berliner's patent claims were "practically worthless" overseas.[61] He then revived the Zon-o-phone in the United States in October while Valiquet applied for the first of a series of gramophone-based patents, just as American Graphophone initiated an infringement suit against National Gramophone and Seaman.[62]

At the end of 1898, Seaman found himself in a serious bind. On the one hand, he was limited in market, sources, and quality by the inventor and manufacturers of the products he sold. To add financial insult to the lack of respect inherent in their treatment of him, Berliner Gramophone billed Seaman for Johnson's efforts to improve a machine Seaman already thought too expensive.[63] On the other hand, his most litigious competitor

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[60]Koenigsberg, xlvi; R. Wile, "The Gramophone," 157-58; Aldridge, 26.

[61]Quoted in R. Wile, "The Gramophone," 161.

[62]Aldridge, 26-27; Koenigsberg, 76.

[63]R. Wile, "The Gramophone," 148-49.

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had sued him and his supplier for infringement of Tainter's universal joint, which Johnson had adapted in rebuilding Berliner's soundbox. Despite his claims about Berliner's patent rights abroad, Seaman and his collection of companies had no legal rights whatsoever. As interests diverged and profits rose, Seaman had no difficulty choosing sides. The graphophone interests represented at law the basic sound recording and reproducing technology, and Seaman was happy to comply with their tactics as long as he could license production of his own version of the disc system.

Section VII: Columbia's Counter-Attack, 1897-1900

For his part, Easton, as head of American Graphophone and Columbia Records, had not ignored the successes of the rival format. In 1897, disc record sales averaged twenty thousand a month; in 1898, they nearly tripled to 57,000. That November, Easton responded by selling "Grand" cylinders, five inches in diameter and five dollars apiece, to dealers as a promotional device. He and Edison had used used these as pantographic masters for years because the greater diameter meant that the record, when rotated at the same frequency as smaller cylinders, travelled under the stylus at a higher velocity. In recording, this meant that the stylus overcame the drag of the wax in recording lower tones, and stretched out the compacted higher frequency sound waves. The result was a louder record in playback, albeit one that took up as much cabinet space as four standard cylinders. Edison followed Columbia's lead, but the ploy failed to

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attract significant sales when customers found that regular cylinders were not nearly as effective at home. Meanwhile, National Gramophone began installment sales of the same gramophone that the sultan in Constantinople had ordered: five dollars down, and seven months at three dollars per.[64] Berliner Gramophone had been selling over a thousand of the improved machines every month since the spring of 1897, and Johnson began building a four-story addition to his factory in 1899 to handle an anticipated increase in sales.[65]

In its advertisements Columbia distinguished the two systems not by the quality of sound but by the versatility of the graphophone. The latter was still designed to record as well as reproduce, and Columbia emphasized that it did far more than Berliner's machine: "it repeats your voice; your friend's voice; songs sung to it or stories told to it." Surely everyone knew, the copywriter argued, that the joy of a "talking machine . . . is derived from its power of recording favorite musical selections, songs sung by loved ones, or the voices of friends." Columbia left questions of sound quality to the

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[64]Gelatt, 89-90; Read and Welch, 89; Brooks, "Columbia Records," 28; Raymond R. Wile, "Berliner Sales Figures," ARSC Journal 11, no. 2-3 (1979): 140-41.

[65]Gelatt, 95-96; Aldridge, 31; R. Wile, "Berliner Sales Figures," 140-42. Johnson told a Camden newspaper in October 1898 that he was producing six hundred machines per week and would soon go up to fifteen hundred by working three shifts. That seems far-fetched as monthly sales peaked in December at 1,362: R. Wile, "Sales Figures," 141. See Read and Welch, 128, for Johnson's claim.

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Phonoscope. Its editor found no favor as the needle started its journey on the lead-in groove of a disc; groove walls more rigid than those on a wax cylinder generated a sound like "escaping steam." The vibrations generated by the spring motor and turntable reminded him "of the rumbling of a horseless carriage. Finally, when the attempt to reproduce a voice is begun, you are forcibly compelled to liken the noise . . . to the braying of a wild ass." Taking the high ground when neither system could claim any classical recordings worthy of the term, the editor concluded that the gramophone's "blasty, whang-doodle noises are not desired by citizens of culture."[66]

Nonetheless, with recording rooms in New York as well as Philadelphia and the capital, Gaisberg had persuaded Dwight Moody and Chauncey Depew, among other notables, to speak into his horn earlier in the year.[67] Seaman also responded with testimonials from his top performers. Cornetist W. Paris Chambers claimed the gramophone "reproduces practically all of the tone quality and volume" of his instrument, while members of John Philip Sousa's band, now under exclusive contract, asserted that only Berliner and Johnson's system "perfectly reproduces the true tone qualities of our respective

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[66]Quoted in Gelatt, 90-91.

[67]Paul Charosh, ed., Berliner Gramophone Records: American Issues, 1892-1900 (Westport, Conn.: 1995), xvii.

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instruments."[68] Indeed, an ad in Munsey's Magazine proclaimed, the Improved Gramophone/Zon-o-phone was not a "'business' machine" where one had to "'talk into it.' Its sole purpose is that of Entertainment--Reproducing Everything in Speech or Music, with fidelity to the originals positively marvelous."[69]

Given the quantity of sound and sales emanating from the gramophone's horn, Easton began looking for a way to move into the disc record business. The challenges lay in surmounting the technical and legal obstacles of the gramophone patents. Early in the fall of 1898, graphophone representatives met with Albert T. Armstrong, financial backer of Joe Jones's failed Wonder talking machine and discs. Jones had not overcome production problems or infringement charges for the machine or the counterfeiture of Berliner discs, but he still had some patent applications that might prove useful in forcing a cross-licensing agreement. American Graphophone agreed to make a thousand Vitaphone machines for Armstrong's American Talking Machine Company, while Armstrong advertised in the Phonoscope for someone to make disc record matrices.[70]

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[68]Quoted in Gelatt, 91; emphasis added.

[69]Advertisement reprinted in Aldridge, 27.

[70]R. Wile, "American Graphophone," 209-10; Koenigsberg, xliii.

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By July 1899, however, American Graphophone found that it could not transfer the skills involved in building a feedscrew graphophone to those needed for a feedscrew gramophone--at least, not at the desired cost. Armstrong had trouble selling the Vitaphone player and red-colored counterfeits of Berliner's discs, which gained the attention of Berliner's lawyers. He turned the contract over to a neighboring company in Bridgeport, Connecticut, International Stylophone, while American Graphophone applied its tools to a handwound disc graphophone for the Christmas season. This machine played vertically-cut wax discs 33/8 inches in diameter which one cued from the inner diameter of the grooved spiral. Easton avoided infringement, but made no impression on the market.[71]

While Easton's combine pursued its own version of the disc technology, his lawyer looked for ways to block the gramophone. American Graphophone's patent attorney, Philip Mauro, looked closely at Johnson's improvements. Drawing on the precedent of successful suits against other infringers, in October 1898 American Graphophone sued Seaman personally along with National Gramophone for using a universal joint in the

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[71]Smart, "Emile Berliner," 355; R. Wile, "American Graphophone," 210.

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gramophone tonearm. Two months later Mauro added the Berliner Gramophone Company to the list of defendants.[72]

Seaman dodged the injunction against sales until the case went to trial and in March 1899 re-capitalized his sales company as the National Gramophone Corporation. His manufacturing subsidiary, the Universal Talking Machine Company, began producing Valiquet's version of the gramophone during the summer. The Zonophone went on sale in the fall. Yet Seaman had no more success than American Graphophone in manufacturing a gramophone as consistently as Johnson. He tried to order quantities of soundboxes from Berliner, which insisted Seaman trade in the defects he was supposedly replacing. He also struggled with the successful electroplating of Berliner's records. Until he hired John English from Edison's staff that fall to make Zonophone matrices from Berliner discs, Seaman had his workers sand down the Berliner label information and engrave their own.[73]

Seaman continued to fulfill his contractual obligations with Berliner, advertising heavily and selling Johnson's and Berliner's products into the

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[72]Aldridge, 29; Gelatt, 92, claims the infringement suit was based on Johnson's use of Tainter's "floating stylus. R. Wile, in "The Gramophone," 164-65, uses court records to show that Mauro drew on earlier successful cases pertaining to the universal joint of the Berliner-Johnson tone-arm.

[73]Gelatt, 94-95; Aldridge, 26; R. Wile, "The Gramophone," 161; R. Wile, "American Graphophone," 212; R. Wile, "Record Piracy," 27; Michael W. Sherman, The Collector's Guide to Victor Records, in collaboration with William R. Moran and Kurt R. Nauck III (Dallas: 1992), 131.

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spring of 1900. Squeezed by his discounts to dealers in competition with the cylinder manufacturers, his own inability to make a reputable player, and the progress of the Graphophone suit, however, Seaman was running out of time and money. In April he tried to bluff his way out with an ultimatum to Parvin: transfer all manufacturing agreements with Johnson to Universal or suffer the consequences.[74]

Parvin refused and on May 5, 1900, National Gramophone admitted in court that the Berliner patents infringed on Tainter's design. Seaman shut off remaining orders to Berliner for sales of gramophone products outside of Washington, D. C., Maryland, and Delaware. Two weeks later he announced a cross-licensing agreement with the American Graphophone and Columbia Records. His Universal company now had exclusive rights, granted by American Graphophone, to make and sell the Zonophone; he claimed to the trade in the Phonoscope that no other disc machine could be legally sold in the United States.[75]

Parvin and Berliner in turn began making arrangements to sell Berliner's goods directly to dealers, based on Seaman's forfeiture of the contract. They issued a prospectus for the Consolidated Talking Machine Company to combine the patent holding and marketing operations,

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[74]Aldridge, 29. The date of the ultimatum is based on the decline in gramophone sales from 801 in March to twenty-nine in April: R. Wile, "Sales Figures," 142.

[75]Gelatt, 95; Sherman, 22.

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exchanging its shares for those of the U. S. Gramophone and Berliner Gramophone. Parvin hired Leon F. Douglass, an early inventor of cylinder duplication techniques who had started in one of Edison's local phonograph companies, to organize the marketing. On June 25, however, a judge agreed with the logic behind Seaman's agreement with Easton and enjoined Berliner from dealing in disc systems. Prevented from selling his own inventions, Emile Berliner countersued and was in turn sued by Seaman.[76]

Section VIII: The Origins of the Victor Talking Machine Company, 1900-1901

While Berliner and the Berliner directors could afford to wait on the results of the judicial duelling, Johnson could not. He had invested his savings, $50-60,000, in machinery and new facilities on the premise that Berliner Gramophone would expand. On the other hand, Johnson was not completely surprised by the legal conflict. After ordering the recording equipment in 1898 and probably after American Graphophone sued Seaman in October, Parvin stopped writing Johnson in order to keep him out of the likely legal conflict between Berliner Gramophone and Seaman.[77] In addition, the machinist had accumulated a substantial number of matrices of Berliner catalogue material based on his recording process. Parvin, besides funding Johnson's research and development, had persuaded him to

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[76]Gelatt, 95-96.

[77]Johnson, "Memorandum," 9-13.

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start training the staff at Berliner Gramophone secretly in his technique. Assisted by Calvin Child, in charge of recording after Fred Gaisberg left to help the Gramophone Company in Europe, Johnson produced twenty-five matrices during the fall of 1898 and made test pressings of the electrotypes at Duranoid. When Bentley Rinehart completed the disc-specific electrotyping system in February 1899, the group made another two hundred over the rest of the year as they began to re-record the Berliner catalog.[78]

This gave Johnson the opportunity to go into the gramophone business for himself. Given his shy nature and ignorance of how to market the products he made, Johnson did not relish the prospect. Still anticipating a resolution of the legal disputes, he began to hire members of the Berliner staff he had been training when that company could not meet its payroll. These included Douglass and Child. By August, however, Johnson himself was running low on cash. He had pushed forward with the wax recording process on the assumptions that someone else would face the inevitable attack from Easton's lawyers and, more generally, that gentlemen settle business conflicts like reasonable men, in order to maximize the industry's sales. Now, it appeared, in order to preserve his own livelihood, Johnson

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[78]Johnson, "Memorandum," 10-11; Aldridge, 29, 31, 103; Gelatt, 96-97. My dating for the beginning of Johnson's recording of the Berliner catalog for commercial, not experimental purposes, six months after Aldridge's, is based on the completion of Johnson's electroplating system.

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would have to put his business on the front line and use his resources to unite the industry.[79]

At the end of the month, Johnson took Douglass to lunch and explained his quandary. He found it "embarassing to manufacture as an infringer goods which came under" Berliner's patents, but he felt he had far more right to do so than Seaman. Still expecting Berliner to triumph and hoping to avoid further confusion in the marketplace, Johnson called his unincorporated organization the Consolidated Talking Machine Company. He had only $5,000 in cash from sales to the Gramophone Company, and he asked Douglass to market his gramophones and new records. In return, Douglass would receive a salary of $5,000 and five percent of the company's net profit.[80]

Douglass, a veteran of the industry, knew a good product and a good opportunity when he saw it. He agreed enthusiastically, and set about lining up dealers in major cities. He also spent $2,500 on ads in Frank Leslie's Popular Monthly, McClure's, Muncey's Magazine, and Cosmopolitan. The

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[79]Johnson, "Memorandum," 12.

[80]E. Johnson, "Memorandum," 12, quote on 14; Leon F. Douglass memoirs, chapter VI, pp. 1, 3, in RCA Collection, Historian's files, box 1, folder 12,Hagley Museum and Library Accession 2069 (hereafter Hagley 2069). E. R. F. Johnson, 60, bases much of his account on the memoir, written in 1940.

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sum astonished Johnson, who was used to investing in capital goods: "My God, Douglass, what will you do next month, there goes half our money!"[81]

Yet it worked. Douglass, working around the illustration of "His Master's Voice" that Johnson obtained from Owen in England, emphasized the technical tradition, that Consolidated's factory had "made all the genuine gramophones in the world."[82] He highlighted the five machines Johnson now offered, ranging from the "Toy," now only three dollars, to a twenty-five dollar model that improved on the Improved Gramophone.[83] The real lure, however, lay in the offer to the 40,000-odd owners of those earlier machines that headlined the halfpage ads: "Gram-o-phone Records FREE: A Marvelous Discovery has just been made in our Laboratory in the art of making records. The results are so startling and the improvements so great that we have decided to give every owner of a Gramophone one of

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[81]Quote from Douglass, VI, p. 1; E. Johnson, "Memorandum," 12; Gelatt, 97-98; E. R. F. Johnson, 55.

[82]Quoted in Gelatt, 98. For far more information on the legendary trademark, see Leonard Petts, The Story of 'Nipper' and the 'his Master's Voice' Picture Painted by Francis Barraud, 2nd rev. ed., (Bournemouth, England: 1983). Nipper did not dominate the advertisements, but his constant presence and Victor's success led to acclaim as one of the most effective ad campaigns in history: see Julian Lewis Watkins, The 100 Greatest Advertisements: Who Wrote Them and What They Did, 2nd rev. ed. (New York: 1959 [1949]), 14-15.

[83]Aldridge, 35, fig. 11.

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these new records free."[84] Customers who wrote for the catalogue picked from Consolidated's four hundred Improved Gramophone Records, all black, single-sided, seven inches in diameter, and designed to play back at seventy revolutions per minute. The differences lay in the new, more legible paper labels, which replaced the stamped information on earlier discs, and in the sound, which no longer included the noises generated from random acid pitting. Johnson also included a sticker on the reverse that explained the leasing agreement between the company and puchaser, a ruse intended to dodge the claim of sales of Berliner recordings and deter counterfeiters.[85]

With the new year, and the proceeds of the holiday season in hand, Johnson and Douglass changed the record label from "Improved" to "Victor" in January, which coincided with their level of confidence and the name of Douglass's wife, Victoria.[86] On Douglass's suggestion, Johnson began recording and pressing ten-inch discs that month, for which he charged a dollar, or double the price of the seven-inch record. It proved an immensely popular and profitable addition, one that became the standard

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[84]Ownership estimated from sales totals in R. Wile, "Sales Figures," 140-42; quote in Gelatt, 98; ad reproduced in Sherman, 23.

[85]Sherman, 22; R. Wile, "Record Piracy," 28.

[86]Douglass, VI, p. 3; E. R. F. Johnson, 56; Sherman, 24-25.

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diameter for popular songs, and over the course of the year Johnson recorded more of the larger discs than the smaller ones.[87]

This is not to suggest that Johnson and Child easily recruited a higher level of performers than what they had obtained with Berliner's process. Recording still entailed persuading "some poor devil to come and sing for a dollar in real money and then . . . push him up the ladder and try to get a record" at the laboratory on South 10th Street in Philadelphia.[88] In the fall of 1900 Child, "a short stocky man . . . possessed of a good deal of personal charm," convinced "a professional entertainer," John O. Terrell, to "risk his reputation by singing for a mechanical device that was still far short of producing the human voice in the sweetness and range of tone of a tenor."[89] Nonetheless, the resulting disc, "I'm Gonna Telegraph My Baby," became Johnson's first hit. Its success resulted from Terrell's musical talent and, as importantly, the perception that the record sounded better by comparison with what consumers had heard before. Johnson attributed much of its success to the wax engraving and in particular to the recording

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[87]Douglass, VIII, p. 1; Sherman, 25. Sherman notes that Johnson's December 1900 catalog listed twenty pages of seven-inch records numbered A-1 through A-487; by October 1901, the number reached A-1011, compared to "nearly six hundred 10" Monarchs": 24-26.

[88]Eldridge Johnson quoted in Charosh, xvi.

[89]E. R. F. Johnson, 59.

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stylus made by an extremely near-sighted mechanic, Bryson Turner, who "could make better cutters than any of us."[90]

Seaman tried to counterattack as his stock of Berliner records and players ran out. In October, he announced in McClure's that the "Zonophone is substituted for the Gramophone, which is abandoned, including its name." Over the course of the fall and winter, he made Johnson the subject of claims of infringement and collusion with Berliner Gramophone in the courts at Trenton, New Jersey; Wilmington, Delaware; and Philadelphia. Seaman had solid circumstantial evidence: Consolidated operated out of the same address as Berliner Gramophone in Philadelphia.[91] Forced to abandon the term "gramophone," Johnson also changed the manufacturing credit on his records from Consolidated to himself, based in Camden. On March 1 a judge in Philadelphia refused Seaman's request for an injunction against the machinist's manufacturing or sales and two months later Johnson regained the right to use the term "gramophone." Ever the salesman, Seaman promptly and unsuccessfully lobbied for Victor's advertising account.[92]

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[90]E. Johnson, "Memorandum," 9.

[91]Gelatt, 93-95; quote on 95; E. Johnson, "Memorandum," 13; Smart, "Emile Berliner," 356.

[92]Gelatt, 98-99; Aldridge, 35, 57. Aldridge, 37, implies that Seaman's advertising agency tried to obtain the account in the next year, but the earlier date aligns with the chronology in that the F. Wallis Armstrong Agency ran

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When a judge lifted the injunction against Berliner Gramophone in July, he did not clarify issue of who controlled the disc record. Johnson had no real interest in the marketplace: "He had none of the ruthless drive of some men for great fortune and the power that goes with it." He wanted to sell out his marketing and distribution interests and settle down to a comfortable existence as a gentleman manufacturer.[93] At the turn of the century, that was the social equivalent of the landed gentry from which Johnson was descended.

By rights, he should have been able to negotiate a reasonable sum from Berliner's Consolidated investors, since he had the business in hand and they only owned the basic patents. He asked for $350,000 in cash, but this was beyond the means of Parvin's group, which resented its relative lack of power. Johnson offered a similar deal to William Owen, now managing director of the Gramophone & Typewriter Ltd., but he was too heavily invested in his new line of machinery to expand back into the United States. With no resolution in sight, Johnson finally invited Parvin and the other Consolidated directors to his house in the Strawberry Mansion neighborhood of Philadelphia. After hearing their bickering over

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Victor's account from 1901 to 1925.

[93]Quote from E. R. F. Johnson, 56; Gelatt, 131.

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the value of their rights, Johnson finally and reluctantly asserted himself: "Gentlemen, there is enough money in this business for all of us."[94]

Most of it, however, would remain in Johnson's hands if he was going to take on Berliner's burden and rationalize the recording business. On October 3, 1901, he incorporated the Victor Talking Machine Company. He septupled the value of his contribution, capitalizing it at $2,500,000 in the form of five thousand shares of preferred stock paying seven percent, and twenty thousand shares of common. Emile Berliner received 500 shares of preferred for his patents. Johnson retained majority control of both issues, parcelling out 1,500 shares preferred and 9,990 shares common to Parvin as trustee for the Consolidated and Victor investors. Among these on the Victor side were Johnson's closest colleagues over the last five years: Douglass, Charles Haddon, Albert Middleton, and foreman Albert Atkinson. They each bought 250 shares of common stock apiece on credit and with Johnson constituted the board of directors.[95]

Some of the names would change with retirements, deaths, or nervous breakdowns, but with this arrangement, Johnson established the structure and operation of his company for nearly thirty years. Victor would

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[94]Aldridge, 35; Gelatt, 111; quote in E. R. F. Johnson, 57.

[95]Aldridge, 35; Uncredited photocopied notes on Victor Talking Machine Company: "Albert W. Atkinson," "General 1901," courtesy Nicholas F. Pensiero (hereafter "Notes on Victor"). The personal and corporate details in this material indicate that these are Ben Aldridge's notes for his history of Victor.

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remain a privately held company whose directors all came from within the company. All agreed with Johnson's strategy, which he described as follows:

> My business policies have always been very simple: first, I try to give as much for a dollar as is possible, and yet make sure of a reasonable profit; second, I have always been satified with a reasonable profit, and have tried to improve the quality of the goods offered for sale in every possible way; third, I have tried to conduct the business so fairly that I should feel satisfied if I were on the other side of the deal; and fourth, I have always made it a rule to never pay dividends or spend money when it was needed in the business.[96]

Section IX: The Entrepeneurs Agree to Disagree, 1901-1903

It was a highly effective approach once Johnson established his leadership in the industry. This he did with remarkable swiftness. For all of the legal maneuvers, at the end of twelve months, Johnson's operation netted $180,000, of which Douglass received $9,000 for his efforts. Johnson probably sold twenty thousand phonographs, a total that would double the following year, and nearly a million records.[97] Seaman's operation was on the run for, at the same prices for records and with less variety in players, his products paled in comparisons of quality or consistency. By the summer of 1901, as dealers abandoned his distribution network for Victor's, the

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[96]Quoted in Aldridge, 51.

[97]Douglass, VI, p. 3; Aldridge, 33. Aldridge, 109, lists the machine total for the last three months of 1901 as 7,570, based on Victor accountant Charles K. Haddon's notebook, now in Hagley 2069, Historian's series, box 1, folder 6. Andre Millard, in America on Record: A History of Recorded Sound (New York: 1995), 49, repeats this number as the year's total. I base my approximations on Johnson's last months of sales to Berliner in early 1900 and his sales at the end of 1901.

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corporation filed for dissolution. Seaman and La Dow reorganized Universal and established a European branch to sell zonophones, where the patent situation was complicated enough to force the Gramophone Company to buy them out.[98]

Resolving competition with Easton took a bit more time. Graphophone's patent counsel rewrote the claims for Joe Jones's patent on wax recording once again in February 1901, and in April the patent office placed it in interference with Berliner's U.S. Patent 548,623 for pressing disc records with a copper electrotype. During this proceeding, George Burt of the celluloid record business hired Universal's matrice-maker, John English, and organized the Globe Record Company in August. Some time later and satisfied with the progress of the interference proceedings, Easton betrayed his former ally, Albert Armstrong, by taking an option to buy Jones's patent for $25,000. On the same day that Johnson incorporated Victor, American Graphophone shipped its forty-dollar disc players to its New York dealer, accompanied by records pressed by Globe for Columbia. A twenty-dollar version followed a few days later. In December, four years after the first application, the patent office finally agreed with Mauro and issued Jones U.S. Patent 688,739.[99]

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[98]Gelatt, 122-25; Aldridge, 104.

[99]Gelatt, 132-33; R. Wile, "The Gramophone," 151, and "American Graphophone," 213-14; Koenigsberg, xlii-xliii, li, 8, 60.

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At this point, Easton executed the option and left the country. He had a disc system offering celluloid records that the copy writer could claim, with some sincerity, were "the sweetest, smoothest, and most brilliant records ever heard. Until you listen to them you can form no accurate idea of the progress that has been made in bringing the disc records [sic] to the point of perfection. Their excellence," a quality that Berliner had acknowledged years before, "is fully equalled by their durability," a quality Berliner had never seen in the pioneer plastic.[100] With Jones's patent, Easton also had a legal club to wield against Victor's records as well as gramophones as well as protection for his arrangement with Burt.

Yet Easton had not formalized his agreement with Burt and while he was overseas, Johnson and Douglass personally bought Globe from Burt in January for $10,000 and contracted to buy 300,000 records by July 1. Together the pair packed up English and the Climax matrices and hied back to Camden. There they put English's talents to work and began pressing Victor records with his matrices.[101] When Easton returned, he had disc players but no discs. A suit followed, but Easton also began negotiating with Johnson in February. He bought Globe back for the same price and agreed to release the various Berliner interests from liabilities for infringement of the broadest

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[100]Quoted in Gelatt, 133.

[101]R. Wile, "American Graphophone," 214-15; Aldridge, 58; Sherman, 27-28. E. R. F. Johnson, 55, places the moving of the matrices with the events of the previous year.

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Bell-Tainter patents. In return, Johnson agreed to let English instruct the Columbia staff on his mastering technique. That spring, Easton moved the Globe plant to Bridgeport, Connecticut, near the Graphophone factory.[102]

Johnson was not yet free of the legal obstacles to making industry as gentlemanly as farming. Easton retained a close relationship with Frank Seaman and Universal as well as the Jones patent, and by these means tried to gain a more substantial place in the disc business. In July 1902, a week after Johnson and Easton met in London to discuss fixing the prices of their products, Seaman succeeded in restoring the injunction against Consolidated.[103] Johnson, continuing to deny any relationship between his operations and that of the Berliner shareholders, sued Graphophone in October for infringement on Johnson's and Berliner's patents through its connections to Seaman's Universal. With great reluctance Johnson was persuaded by Owen in England to buy the American zonophone business, and in December Seaman, assisted by Mauro, dropped his claims and settled out of court with Johnson for $40,000.[104]

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[102]Read and Welch, 133; Aldridge, 59; R. Wile, "American Graphophone," 215.

[103]Diary, Eldridge Reeves Johnson Papers, Eldridge Johnson Museum, Dover, Delaware: photocopied from originals at the American Historical Center, Laramie, Wyoming (hereafter Johnson Papers); Aldridge, 37.

[104]Read and Welch, 134-35; E. Johnson, "Memorandum," 15; Aldridge, 37, although he later dates the settlement as 1901: 104.

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Johnson sued again in July 1903 for infringement of his soundbox patent (U.S. Patent 670,896). Easton was a reasonable man. He and Mauro had made Columbia the dominant member of the recording industry in the 1890s through assiduous use of lawsuits for infringement of the Bell-Tainter patents, but that era was coming to an end. The basic Volta patents had expired in May, and all Easton had now was the Jones patent and the clever Mauro to defend it against Johnson's claim of prior conception. Moreover, Edison had returned from the hills of northern New Jersey and was devoting his energies again to the phonograph. In February 1902 he debuted his new 160-rpm wax cylinders, mass-produced through a patented moulding process. This system offered more consistent production of cylinder copies than pantography. The cylinders themselves generated a louder sound from the higher speed and harder wax grooves formed under pressure, rather than the direct cut of a stylus, and therefore in production and loudness now offered a competitive rival to the disc. Edison's production jumped from 2,000,000 in each of the previous two years to 4,400,000 in the next twelve months.[105]

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[105]Gelatt, 159; Leonard De Graaf, "Confronting the Mass Market: Thomas Edison and the Entertainment Phonograph," paper presented at the Interpreting Edison Conference, Rutgers University-Newark, New Jersey, June 25, 1997, 11. My thanks to Dr. David Sicilia, University of Maryland, College Park, for providing a copy. For more details on the development of the cylinder format, see Read and Welch, 152-53; Koenigsberg, xlv-xlvi, liv, lv-lvi.

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Johnson on the other hand had no guarantee that the judiciary would agree with him. He and Easton agreed to cross licenses on December 8, 1903, and let the "the industry to get on with its business."[106] It was a gentleman's agreement, where the best man would win in the marketplace, not the courthouse, although rising sales of discs and cylinders suggested that everyone who gave their market what it wanted would profit handsomely. And for the next twenty years, that was the case.

Section X: The Success of the Victor Talking Machine Company, 1901-1924

Johnson occupied himself with more than legal maneuvers after incorporation. By 1907, the machinist-turned-industrialist had established the strategy and structures that enabled him to carry out his plans for making his company the industry leader in recorded sound. For all of the emphasis on Victor's use of celebrity performers and trademark advertising as the basis for this success, Johnson also worked at technical and industrial levels to gain acceptance for his system in middle- and upper-class parlors and sitting rooms.[107] He improved Berliner's system stylistically and acoustically, expanded his organization and plant vertically and laterally,

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[106]Aldridge, 37; R. Wile, "American Graphophone," 215; quote from E. R. F. Johnson, 72.

[107]See Marsha Seifert, "Aesthetics, Technology, and the Capitalization of Culture: How the Talking Machine Became a Musical Instrument," Science in Context 8, no. 2 (1995): 417-49, for a scholarly version of this argument, but see also Gelatt, 141-42, 148-49.

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and delegated responsibility to the other directors. He responded to the suggestions and arguments of gramophone staff at home and abroad, to the nature of his consumers' tastes, to the competition from Columbia and Edison, and to his own determination to establish Victor players and records as the most popular brand in the United States. There was nothing certain or simple about the process; behind the allure of the advertising lay, as he recalled, "only a hard pounding for twenty years."[108]

The goal and technical requirements were apparent enough. Johnson understood the culture of the upper classes and he was by trade a precision machinist. Yet the worlds in which he dwelled, the affluent Main Line outside Philadelphia and the tools and dies of the machine shop, clashed when it came to selling his products. He had already transformed the gramophone from a toy fit for street performers to a talking machine; at times it strained his credulity that he could market it as a musical machine, much less an instrument worthy of the premium charged for high culture and mahogany veneer. Victor's development was thus a curious mix of Johnson's technical determination "to improve everything we do every day" and his dubious acquiescence to what the market would bear: what people would pay for records by celebrity performers, or for a machine designed to match the furniture of a sitting room. As a result, it took time

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[108]Quoted in Robert Frothingham, "Little Advertising Stories: The Victor," Everybody's Magazine, July 1910, 80e, copy in Hagley 2069, Historian's series, box 2, folder 78.

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for Victor's marketing to gel in the form we now remember. Johnson was not the sole inventor of any of the components which collectively established Victor's reputation, but the form of his commitment to the technology explains the company's success and, ultimately, its stagnation.

Section XI: Marketing the Talking Machine, 1901-1922

Johnson founded his empire on the insight he had realized on first encountering Berliner's gramophone. In his only nationally distributed interview, Johnson explained that perfecting the gramophone would result in a "totally new branch of public culture," aligned in the average American household with the library and piano:

> The books may be few and the piano indifferent, but the average family realizes the need of both. The family also needs a good automatic instrument for reproducing the world's best music, as well as the popular jollities. Culture and joyousness alike require such an adjunct in every household.[109]

This was the vision he put before the ad man from F. Wallis Armstrong, which held the Victor account from 1901 to 1925. The public did not yet know it needed a Victor player and records, but with Armstrong's help, it would find out.

Victor's advertisements, in which Johnson took a personal interest after the early successes, therefore emphasized Victor's system as one that blended technology and culture. As befitted the hybrid origins and nature of the product, the ad campaign did not hammer home one selling point.

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[109]Ibid., 80g.

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Well into the 1920s, ad copy emphasized four appeals of the product: the superior workmanship of the players and the quality of the recordings, the cultural advantages and prestige that came with ownership, access to the best classical performers in Europe, and the notion that the system was "the gift that keeps on giving."[110]

The response to these claims came only with time. At a fundamental level, customers found that they got what they paid for. The spring motors did not jam or break down and they maintained a relatively consistent speed for the turntable. As none of the disc companies established a standard speed, adjustments remained up to the listener. The records did not feature the noise of Berliner's acid-etched discs, and the volume generated by the rigid groove walls covered a multitude of other drawbacks to the Victor disc. By quintupling the dynamic range to nearly thirty decibels, Johnson enabled singers and ensembles to overwhelm the steady grating of the needle against the mineral particles in the record.[111] That same volume meant that rough handling of the discs had less effect on the signal-to-noise ratio than similar treatment of the delicate wax cylinders. Finally, customers could choose from a wide array of musics and

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[110]Aldridge, 47-49.

[111]Isom, "Record Materials, Part II," 723.

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performers, all clearly marked on the new paper labels that Johnson received a patent for in 1903.[112]

Johnson reinforced these impressions through what his Armstrong agent called "roast beef copy." Like many manufacturers of staple goods, Victor assured the customer of its products' consistency and excellence. In the talking machine's case, this was not to replace local brands but improve the reputation of a technology long seen as a novelty or lower-class entertainment. Over the first six years of an expanding campaign of full-page advertising in magazines catering to the urban middle and upper classes, Johnson and Armstrong built up "public confidence that the Victor was all we claimed," that Victor offered "a perfect reproduction of the best singers and instrumentalists in the world, and you can have any of them in your home any hour of the day."[113] Ads in Talking Machine World explained to Victor's dealers the rationale behind promoting opera singers rather than popular performers: "our business is just the other way, and more, too; but there is good advertising in Grand Opera."[114]

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[112]U. S. Patent no. 739,318, filed for August 8, 1900.

[113]Quotes from the unnamed Armstrong agent in Frothingham, 80h; see Susan Strasser, Satisfaction Guaranteed: The Making of the American Mass Market (Washington, D. C.: 1989), 113-15, for examples of reassurance in other industries.

[114]Quoted in Gelatt, 143.

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Enrico Caruso was only one of Victor's stars in the initial years of publicity. His reputation would grow in part because his one potential rival, Francesco Tamagno, died of heart disease in 1905; in part because he was uniquely talented and skilled; and in part because no other tenor had a voice quite as well suited to acoustic recording.[115] The fact that Caruso sang for the gramophone just as he was gaining a reputation reinforced the point of two ads Johnson devised. In them, Victor mourned with the reader the loss of the voice of Jenny Lind and the violin of Ole Bull. A consumer buying a Victor system, Johnson implied, contributed to the preservation as well as the appreciation of high culture.[116] The overall point of Victor's classical advertising, then, emphasized not one performer, but that the label had everyone worthy of a recorded legacy.

Like the marketers for Kodak cameras, another technology designed for consumer entertainment, Johnson and the agent rejected streetcar ads and billboards as mediums directed at the working classes.[117] Newspapers were used only to announce weekly record releases and the "Opening Day"

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[115]P. G. Hurst in The Golden Age Recorded, new and rev. ed (London?: 1963), 9, ties the acme of operatic singing to Augustus Harris's entrepreneurship at Covent Garden shortly before the turn of the century.

[116]Frothingham, 80h.

[117]Siefert, "Aesthetics," 439, cites an example of streetcar advertising from 1906 for Victor's opera stars, but it may be that Johnson and Armstrong abandoned this tactic or that they selected demographically favorable streetcar lines: those linking a city to its suburbs, for example.

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of a new record player. Coincident with the innovation of the enclosed-horn Victrola in 1906-07, the Armstrong agent and Johnson began adding "the salads and desserts" of "taste and fancy" to their formula, all the while increasing the investment in advertising. By the mid-1910s, Victor was the 174th largest company in the country based on assets, but among the top five spenders on national magazine advertising.[118] It was this campaign, centered around the Victrola, that established the company's image.

Having raised interest in his system, Johnson had to make it available in an appropriate and familiar commercial setting for his clientele. Here he built upon a pattern of distribution pioneered by the cylinder companies. Until 1900, Easton, like Berliner and Seaman, followed Edison's lead and operated his own network of dealers and distributors for a unique device. At the turn of the century, however, music dealers began stocking Columbia and Edison systems.

They also began carrying "piano-players," $250 additions to the piano that played a span of sixty-five notes via a punched roll of paper as one provided power through foot pedals. The Aeolian Corporation in New York City, renamed after the Greek-revival concert hall, led an industry that thrived on the disinterest of piano buyers in learning how to play the instrument. Just before 1900, Aeolian introduced its "Pianola," providing a

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[118]Quotes from Armstrong agent in Frothingham, 80g; Strasser, 102; Aldridge, 49, 56-57; Daniel Pope, The Making of Modern Advertising (New York: 1983), 44.

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diminutive brandname to fit a device designed to resemble a half-size piano. The company led its industry in marketing and production, using the same full-page magazine ad techniques of other firms catering to the upper-class home and gradually buying out much of the competition.[119]

While Johnson and Douglass built on Seaman's network of dealers, they also recruited wholesalers specializing in music whenever possible. Rudolph Wurlitzer, makers and dealers of musical instruments, automatic pianos, and music boxes, had already signed on by September 1901. That fall, Johnson persuaded Lyon and Healy, the most prestigious music house in the country, to carry Victor products.[120] Now those customers looking for sheet music, a piano, or a music machine, also heard the talking machine, as well as the expanded variety of performances.

This was an important issue when the prestige of the product rested on how people understood its place in society. That in turn depended on where they bought it and on what sort of performances they could hear on it. For twenty-five years sound recording had been marketed by its inventors and investors as a novelty, business machine, and a low-culture alternative to live vaudeville and street performers. From the local phonograph companies to Emile Berliner, men had moved the system from

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[119]Harvey N. Roehl, Keys to a Musical Past (Vestal, NY: 1968), 4-6; Guy Marco, ed., Encyclopedia of Recorded Sound, s.v. "Aeolian Co."

[120]Read and Welch, 156; Roehl, 28-29; Seifert, "Aesthetics," 434; Aldridge, 46, 107.

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public to private entertainment. Now Johnson aimed higher, but he had to make the machine familiar, the records appropriate, and both acceptable to upper class society.

Given the competitive situation with Edison's phonograph and music machines, Johnson's primary concern in integrating forward was to prevent unauthorized price-cutting. To that end, Victor machines began carrying a license-to-sell notice in March 1902. In 1906 Douglass and patent counsel Horace Pettit worked out a more rigorous policy that required dealers and distributors to maintain prices, offer service on Victor machines, and contribute to the sales effort. In return they received $25-35 worth of sales aids from Camden, including the company's sales magazine, Voice of the Victor. As the Sherman Anti-Trust Act did not explain the place of patents in corporate interference with the market, the company's directors reasoned that Victor products were manifestations of the patents over which the company held a monopoly. Therefore it could license the players and records on its own terms and by 1916, over six thousand dealers agreed. The requirement that Victor dealers gross at least $300 annually indicates the small scale of many of these businesses. They relied on price maintenance to stay competitive with the spread of department stores, which rotated the lines of various brand-name manufacturers as loss-leaders to lure in customers. The Supreme Court struck down Victor's restrictions in 1917 on behalf of the R. H. Macy Department Store, but in a

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period where demand exceeded supply, most dealers continued to abide by the policy.[121]

To build the future market for the elite recordings, Johnson began an Educational Department in April 1911. Frances Elliot Clark oversaw an extensive effort to encourage the use of Victor products in music classes. This effort accounted for the continued sales of exposed-horn players and coincided with the publication of Samuel H. Rous's The Victor Book of the Opera, first issued in 1912. At seventy-five cents and 375 pages, this book was a high-cultural, fully illustrated analogy to the cookbooks offered by the Shredded Wheat and Baker Companies. It summarized the plots of seventy operas for which Victor offered excerpts and arias. Rous's evaluation of the performers was hardly critical and, in the case of multiple renditions of one scene or aria, he merely applauded the performances of Victor artists in descending order of reputation and, implicitly, record price.[122]

Section XII: Marketing the Victor Record, 1902-1922

As for records, Johnson started pressing his own discs in Camden in July 1902, using a new method of electrotyping that enabled him to create multiple negative stampers from one master recording. Now a performer

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[121]Victor Talking Machine Company v. Nathan Strauss, April 9, 1917; Aldridge, 49, 57-58, 67, 73. The earlier claim that the company had over 10,000 dealers is probably legitimate; Victor cut off over 4,800 dealers between 1912 and 1914. See Strasser, 269-85, for more on the different perspectives regarding price maintenance.

[122]Strasser, 131; Gelatt, 150-51.

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did not have return to rerecord a performance when the stamper wore out after five hundred discs; one recording lasted indefinitely. By December Johnson was pressing two thousand discs a day.[123]

The record itself would change very little in composition over the next forty-five years. The ingredients continued to be those of the proprietary Duranoid blend of shellac, "strengthening ingredients" or slate and limestone dust, and carbon black.[124] Each of these materials helped establish the disc record as an icon of recorded sound, and the Victor version as the one best remembered.

The key ingredient was shellac, a natural plastic of unique properties and exceptionally ill-defined composition. The word originated in the Sanskrit term for "100,000," which referred to the swarms of the lac insects (Tachardia lacca) whose female members exuded the base material on tree branches before giving birth to live young. The result was bags of "buttons" or flakes of a resin comprised of a free carboxyl, several ester groups, a partly free and partly combined aldehyde group, four to five hydroxyl groups, all having a molecular weight of 800 to 1,000. It was impossible to assign it a chemical structure even in the 1960s but its thermoplastic properties and heat resistance made it ideal for detailed molding and recycling in

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[123]Johnson Diary, Johnson Papers; Aldridge, 45, 59, 104; R. Wile, "American Graphophone," 218 n. 15.

[124]Johnson's U. S. Patent no. 888,089, "Record for Talking-machines."

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production. Despite efforts to rationalize or mechanize the production of these insects, the material remained indigenous to India and a product of handicraft until the 1950s. During the years of its use in records, millions of peasants collected twigs of sticklac for processing in local villages where skilled craftspeople refined it. Merchants graded the product in a number of categories based on the level of refinement and its color, which ranged from "blonde" to dark red.[125]

Shellac provided between fifteen to thirty percent of the record in the proprietary blends used by manufacturers. They had to weigh the clearer sound that came with more of the plastic against the expense of the latter and its wearability under the stylus and tone-arm. Mineral dust--varying mixtures of slate, limestone, and silicates--gave records their weight, their low cost, their resistance to wear, and the characteristic "scratch" of the steel stylus moving over the particles in the groove walls or the craters left when the stylus dislodged them. Johnson concluded that durability and loudness offset the needle scratch. The noise also aided sales of needles, which the

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[125]For the origins of shellac and its use in records, see Edward Hicks, Shellac: Its Origins and Applications (Privately published, 1961), 11-12, 114-15. For the ecology of the insect and its host trees, see A. P. Kapur, "The Lac Insect," in Mukhopadhyay and Muthana, eds., A Monograph on Lac (India: 1964), 59-88. For the challenges in developing a shellac industry outside India, see S. N. Gupta, "Lac Cultivation Outside India," in idem, 114-44. For the fascinating process of lac production and its grading, see T. Bhowmik, "Technology of Lac: (a) Indigenous Method of Processing Lac," in idem, 156-78. For its composition, see N. R. Kamath, "Chemistry of Lac," in idem, 197-220, and The Commodity Yearbook, Master ed. (New York: 1942), 289.

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company recommended consumers replace after every record played, and from which sales Victor grossed over a million dollars annually during World War I.[126]

A small percentage of carbon black gave records their characteristic color and it was the only ingredient used in records from the nineteenth to the twenty-first century. Among other "coloring pigments," it maintained the blackness of Berliner's hard-rubber records and distinguished Victor records from those of the competition. Without it, Johnson's discs would have displayed the mottled variability of wax cylinders. Shellac ranged in color and purity from bits of lac bugs and other debris, while the mineral powder varied in color with the mineral and the supplier. The carbon in the Duranoid mix cloaked records in the formality suitable to the late Victorian high culture, just as it made buttons formal and discreet. Only in the late 1920s would the qualities of carbon black in lubricating the groove, thus smoothing the movement of the stylus, emerge as an unexpected benefit.[127]

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[126]Hicks, 115; For needles, see Aldridge, 75.

[127]There is exceptionally little discussion on why records are historically black. J. M. Huber Corporation, Victor's carbon black supplier in the 1950s, issued a booklet honoring the label's fiftieth birthday that did not explain the origins of the technological or corporate relationship: "On the Record . . . The 50th Birthday of Victor Red Seal: Huber Salutes This Famous Huber Carbon Black Customer" (1953), Hagley Museum and Library. Robert Angus wrote two articles on the subject as it pertained to vinyl records in the 1970s. The one I have seen, "Why do Records Have to be Black Anyway?" High Fidelity, July 1974, 68, explores the issue only for vinyl

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Black also offered the face of reassuring consistency to consumers still leery of products manufactured beyond their local community, as well as the implicit formality that upper-class consumers sought at the end of the Victorian era. Colors, such as those with Edison and others dyed their celluloid cylinders, implied a sense of childishness and novelty in records that has persisted. At the time, commercial designers and colorists compared color, "like music," to "the language of emotion." For Johnson and Victor, however, a disc containing a Caruso aria or the "real sentiment" of an Ada Jones Bowery routine, needed no material promotion. That would represent an excess that cheapened the cultural value of the disc.[128]

Johnson experimented with a variety of formats, speeds, and trademarked descriptions of his records in the early years. An engraving of Nipper and the talking machine appeared on the label for the first time in January 1902. The innovation of the ten-inch disc occasioned the "Victor Monarch Record" label in January 1901, which lasted into 1905. The effective doubling of playback diameter added only a minute to the playing time because Johnson began raising the speed to seventy-eight rpm. Why

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based records, which will addressed in Chapter 6. My thanks to Carlene Stephens, National Museum of American History, for locating this citation. The technical benefits of carbon black for the 78 will be discussed in Chapter Four.

[128]Color quotes cited in William Leach, Land of Desire: Merchants, Power, and the Rise of a New American Culture (New York: 1993), 77, see also 169; Jones quote cited in William Howland Kenney, Recorded Music in American Life: The Phonograph in Popular Memory (New York: 1999), 37.

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he did so remains open,[129] but it became the standard Victor speed for all records but the "Deluxe," a two-dollar fourteen-inch disc introduced in March 1903. This offered six minutes of music when consumers adjusted their motor governors to 60-rpm. Johnson, with Douglass's prodding, also recorded on twelve-inch wax blanks in May 1902 but held their release for a year. This too was a Deluxe, but for only $1.50, which promoted the fourteen-inch disc to the "Deluxe Special" before they withdrew the oversized and overweight format after Christmas 1904. Johnson did not identify all of his records as "Victor" products until January 1905. Fixing the format took longer; the company continued to release seven-inch discs into 1907, and produced eight-inch records from 1906 to 1909.[130]

The concept of an elite red seal label came from tsarist Russia.[131] Since leaving Philadelphia in 1898, Fred Gaisberg had criss-crossed Europe in search of singers for the Gramophone Company's catalog. In April 1901, the dealer on Nevsky Prospect in St. Petersburg suggested that the company

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[129]Siefert, "Aesthetics," 439 n. 23, suggests that the movement arose from the need to reproduce certain tones in various artists' performances. Fred Gaisberg first recorded Caruso in March 1902 at 73-74 rpm: Robert and Celia Dearling, The Guiness Book of Recorded Sound, with Brian Rust (Enfield, Middlesex, U. K.: 1984), 58. Gaisberg himself never indicated that he adjusted the speed upward at this session based on his attendance at one of Caruso's operatic performances.

[130]Sherman, 25, 27, 31, 36, 39, 42; Read and Welch, 160, note that the fourteen-inch disc weighed over a pound.

[131]See Koenigsberg, lv, for illustration of patent, also lvi-lvii.

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highlight records by members of the Imperial Opera on the new ten-inch record format with a red label. The exclusive application would justify a five-dollar price to his aristocratic clientele. Gaisberg returned in June to carry out the new recordings, which went on sale the following winter for the equivalent of $2.50 apiece. In Russia "they sold like hot cakes," caught on at Berliner's Deutsche Grammophon operation, and then at Gramophone in 1902, when Gaisberg began recording the stars of the Covent Garden Opera House.[132]

At this time, Victor was doing extremely well with the traditional repertoire of band pieces, pop songs, and monologues at a set price. By September 1901, Johnson invested in full-page ads touting John Philips Sousa's signed quote, "Your 'Victor' and 'Monarch' Records are all right." Even then, the company asserted that its talking machine was "so perfect as to be mistaken for the original band, orchestra or singer."[133] As to classical offerings, a baritone from Brooklyn covered a small repertoire in English, French, and Italian under three pseudonyms because Victor's contract with Gramophone arranged only for the export of records, not an exchange.

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[132]Fred Gaisberg, The Music Goes Round, (New York: 1942), 30-31, quote on 30; Jerrold N. Moore, A Matter of Records (New York: 1977), 56-60, 75; Gelatt, 112, 115-16; Sherman, 34-35; Koenigsberg, lvii. The greatest stars of the Imperial Opera, Feodor Chaliapin among them, were not recorded until the fall, presumably by Gaisberg's assistant, Sinkler Darby, when Owen paid nearly $5,000 for sixty recordings: Russell Miller and Roger Boar, The Incredible Music Machine ed. Jacques Lowe, (London: 1982), 61.

[133]Advertisement reproduced in E. R. F. Johnson, 62.

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Nonetheless, the number of records sold in the last three months of the year jumped from 257,000 in 1901 to 428,000 in 1902. Overall, Victor's net profit more than tripled to $495,000 while the company grossed more from sales of records than players for most of the first decade even as the unit sales price remained stable.[134]

As for the performers on disc, Victor responded to Easton's efforts to gain an edge in the spring of 1903. Columbia paid the leading performers of the Metropolitan Opera one to three thousand dollars for three ten-inch, three-minute recordings, which went on sale in April for two dollars each. Lacking Johnson's new electroplating method, Columbia would have to sell a high percentage of the records pressed just to break even. By comparison, Enrico Caruso's demand a month before of fifty dollars per recording seemed paltry, and Easton realized too late that he had misjudged the economics of the high-end market. Poor recording quality did not aid sales, perhaps because Columbia kept pressing with worn stampers, and Easton pulled the plug on the Grand Opera campaign after Christmas.[135]

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[134]Gelatt, 135; Charles K. Haddon's notebook, Hagley 2069, Historian's series, box 1, folder 6; Douglass, VI, p. 3; Aldridge, 55-56, 59, provides specific gross and net profits for 1902-1905. The Haddon notebook indicates that record sales outstripped players through 1908, while the unit sales price actually declined from thirty-nine to thirty-four cents between 1905 and 1908.

[135]Gelatt, 136-37, 139. Gaisberg paid Caruso £100 for ten recordings. Millard, in America on Record, 59, is the only source to footnote his source at the EMI Archives. He writes that Caruso earned the equivalent of $400, or £80, but his figure may be confused with the $4,000 Caruso received in his

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Nonetheless, word from Owen and Royal about the red label phenomenon in Europe and a new contract to obtain matrices of Gaisberg's recordings, combined with Columbia's initiative, convinced Johnson to try the high-culture approach. Victor began issuing imported ten-inch Red Seals in March 1903 for $2.50 and making its own elite recordings at the end of April in a room at Carnegie Hall. These went on sale in June for two dollars apiece. The apparent success of the mark-up based on musical celebrity alone led Johnson issue domestic twelve-inch Red Seals in the fall, for three dollars, even before he offered the larger format to the Gramophone Company.[136] Such high prices demanded special marketing, like the first ever two-page advertisement in the Saturday Evening Post in April announcing that "the voice of Melba[,] Caruso and others can now be heard on the Victor Talking Machine. . . . It is the greatest musical instrument in the world." Increasingly expensive Red Seals followed, and in the spring of 1908 Victor issued an all-star recording of the sextette from Lucia di Lammermoor for seven dollars. This it justified to its dealers as a "profit leader" that would attract customers precisely because they could not afford it, and to its customers as far cheaper than an exclusive booking of the performers in their homes. Storeowners stocking three to five thousand

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first American contract in 1904 for ten recordings.

[136]Aldridge, 56; Gelatt, 137-38; Sherman, 36-38.

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records to stay current, up from the thousand-plus that one Edison store carried in 1892, could hardly complain.[137]

Section XIII: The Victrola Rules the Market

While Johnson arranged early on for appropriate distribution channels for his system, he was also concerned with its appearance. The phonograph makers had a certain amount of precedent in the sewing machine in both appearance and manufacturing pedigree; the square-based gramophone and its exposed horn represented, however, a new shape in the home.[138] Embellishing the cabinet containing the turntable did not conceal the movement of the soundbox and horn across the record or overcome the fact "that ladies did not like mechanical looking things in their parlors."[139] Over the next two years Johnson and Douglass filed for patents on a "cabinet for talking machines," where "all of the movable parts of the machine may be more efficiently and completely inclosed . . . and which when the

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[137]Ad reproduced in Sherman, 32-33, and 96-97; Millard, Edison and the Business of Innovation (Baltimore: 1990), 55-56.

[138]The American Graphophone Company took over Elias Howe's sewing machine factory in Bridgeport and employed many of its worker to produce the treadle mechanisms and rectangular stands, while Edison provided a removable top casing for his phonographs: Read and Welch, 178-79.

[139]Quote from Douglass, VIII, p. 1.

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machine is not in use will have a pleasing and attractive appearance in any room."[140]

Better homes required more than raised cabinet walls, however, for they were inhabited by wealthier consumers with larger rooms who bought the most records. While furniture manufacturers began offering record cabinets, Johnson tried to accomodate the demand for more volume with larger and more stylish horns. These had the dual effect of making recorded entertainment even more obtrusive and accelerating the wear on the record groove walls.[141] Johnson needed to enclose the source of music completely. Such a design for the table top would resemble those of disc-operated organettes or music boxes; a standing cabinet would challenge the bulkier and more expensive devices that vaguely resembled china cabinets.

Providing a cabinet big enough to enclose the horn, store records, and hold the turntable seemed an obvious solution, but making it a reality required considerable work to match Johnson's dedication to better sound. For even as he began working on enclosure Johnson had improved the exposed horn. In the fall of 1903 he introduced a tapered, hollow gooseneck tonearm through which the sound travelled from the diaphraghm to the

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[140]U. S. Patent nos. 774,435 and 779,030, respectively: Douglass, VIII, p. 1; Koenigsberg, 48. Johnson's patent is quoted in Koenigsberg, lxi.

[141]Read and Welch, 180; Robert W. Baumbach, Look for the Dog: The Victor Talking Machine Companion (Woodland Hills, CA: 1994 [fourth printing]), 11, points out that the problem was not the mass of the counterbalanced horn but the inertial force it exerted on the stylus.

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horn's mouth. Mounted on ball bearings and held over the record by a large brace, the soundbox and stylus could track the groove with minimal resistance. In addition, the gradual curvilinear expansion of the passage through which the soundwaves travelled significantly reduced their distortion. As a result, claimed the copy writer, a Victor machine had "become, more than ever, a musical instrument."[142]

Nonetheless, "the horn continued to be an affront to people of refined taste." Johnson applied the principle of gradual expansion to the enclosed horn with a sketch in October 1903. Between then and the Victrola's debut in August 1906, Johnson and his staff worked with a series of cabinetmaking companies on the problems of containing an enclosed soundwave.[143] Redirecting it inside the frame of the turntable stand required isolating and damping the vibration of the speaker walls to prevent them from feeding back to the turntable and stylus and to limit the distortion of the wave itself.

When the time came to roll out the Victor-Victrola in November 1906, Douglass initially ordered two hundred, and he and Johnson were less than certain at the likely response to a record player that, at $200, cost twice

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[142]Quoted in Gelatt, 135; Aldridge, 55-56.

[143]Quote from E. R. F. Johnson, 73-76; Koenigsberg, lxiv, lxvi.

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as much as the top-of-the-line Victor VI.[144] The company sold 506 of the new model in the final months of the year, and 3,600 during the bank panic and recession of 1907. These totals were not remarkable considering the advertising campaign or compared to the 98,000 exposed-horn players Victor sold in the latter year. Columbia introduced its own version in June 1907, leading Johnson to arrange another cross-licensing agreement.[145]

The next four years saw competition, continuous advertising, word of mouth, and cheaper models. The Victor-Victrola became the Victrola, and Johnson based virtually the entire campaign on the Aeolian Company's marketing of the pianola. By 1911 Johnson was selling three times as many of the trademarked Victrolas as those machines with exposed horns. At the height of phonograph popularity in 1917, Victor sold 564,000 Victrolas, evenly divided between table-top and cabinet versions, and only 6,600 exposed horn players.[146]

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[144]Douglass, VIII, p. 1; Baumbach, 39.

[145]Aldridge, 61, 109; latter page mostly reprinted in Baumbach, 8.

[146]W. J. G. Ord-Hume, Pianola: The History of the Self-Playing Piano (London: 1984) 26; Aldridge, 61, 109; latter page mostly reprinted in Baumbach, 8; Koenigsberg, lxix. Victor shipped one machine to Denver in August and began regular shipments November 3. Edward MacEwan, Johnson's brother-in-law, wrote him in England on October 4 to tell him "the Victrola is a winner": quoted in E. R. F. Johnson, 81.

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As for Victor's competition, Johnson's organization of the patent oligopoly between the three leading companies limited the record business. First Columbia and then Edison fell behind, as did the less expensive music machines. They did so not because of any momentum gathered by the Berliner disc, but as a result of the predispositions and decisions of their managers. Easton never devoted the resources to vertical integration of the manufacture of playback systems, while Edison became obsessed with marketing the quality of sound to an audience that could not afford it. The roller organ and music box companies, lacking any patentable qualities that would encourage industrial consolidation and little understanding of the change in scale of advertising necessary to survive, fell into rapid decline before World War I. Only the player piano firms continued to thrive, based on further refinements to better capture the qualities of individual pianists, all of whom recorded and endorsed the manufacturers. Like Victor, Aeolian and other companies thrived on high-culture, celebrity, high-quality craftsmanship, and large-scale advertising.[147]

Easton, having divided his resources to cover both the cylinder and disc markets, knew that American Graphophone lacked the craft skills to make gramophones of consistent quality. The struggle to make precision

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[147]Q. David Bowers, Encyclopedia of Automatic Musical Instruments (Vestal, NY: 1972), 13, 99, 274, 281-85, 741; Ord-Hume, 24-38, and chapters 3-7.

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machines consistently had a tradition reaching back to Tainter's efforts to make a prototype to show Edison in 1886. Easton was a businessman, not a mechanic or engineer, realized that his opportunity to control the industry had passed with the loss of patent control and Edison's return to the market. With the appearance of Victor, his prime interest lay not in investing in the skills and capital required to innovate systems on a mass-market scale, but in surviving in the niche he understood best, that of records. Columbia continued to make playback machines but, aided by the assets of Burt's Globe Record Company, concentrated on profit-taking in the cylinder sector while trying to collect its share of Johnson's expanding disc market.

After the Grand Opera debacle, then, Easton tried a number of other innovations in the disc format. A brief association with Guglielmo Marconi, whom Easton hired as "consulting physicist" in 1906, led to the "Marconi Velvet-tone Record." These discs, made of some flexible plastic, appeared in 1907 with ads touting the elimination of "the annoyance of the usual scratching sound" and a photograph of Marconi bending one. The lack of filler to resist the needle pressure meant that the sound quality deteriorated after one playback, however, and Easton abandoned the project in a few months.[148]

Easton was somewhat more successful with an innovation aimed at lowering costs. Through his connections to the Zonophone interests in

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[148]Gelatt, 152.

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Europe, he licensed a two-sided record patent. In August 1904 Columbia began offering a ten-inch disc which, for $1.50, gave the customer songs at seventy-five percent of the cost of Victor's. Four years later Columbia finally responded to Victor's Red Seal performers by licensing the American rights to opera singers on the European Odeon and Fonotipia labels. Alessandro Bonci had less of a domestic reputation, however, as well as a less distinctive voice, and sales of two of his arias at $3.50 never matched those of Caruso's, which continued to cost three dollars each. By 1910 Easton ended the agreement and began recording singers domestically, although his recorders fared no better at the ears of critics two generations later.[149] In general, Columbia took the low road, charging twenty-five cents a record, which provided Easton and the stockholders with a steady profit. In 1904 and 1905, American Graphophone netted $730,000 and $804,000 while Victor's profits rose from $424,000 to $607,000.[150]

Edison initially did even better, as his staff reduced the cost of manufacturing molded cylinders by more than half to three cents apiece by 1903 and had more experience in making the phonograph despite Edison's erratic management. After Victor appeared to draw even with Edison in

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[149]Ibid., 151-56; Koenigsberg, lvii-lviii.

[150]"Report to Stockholders of the American Graphophone Company from October 1st, 1903 to September 30th, 1904," 2; idem, "October 1st, 1904 to September 30th, 1905," 2; Aldridge, 59. Annual reports courtesy of Nicholas F. Pensiero and now Hagley 2138.

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gross sales in 1902, just as the latter introduced the molded cylinder, Edison's sales ran between fifty to one hundred percent ahead until the Panic of 1907.[151]

Yet in the record end of the business he was caught between a hard disc and soft prices. Edison's product at fifty cents and two minutes playing duration could not compete with Easton's cylinders, Johnson's three-minute discs, or music machine rolls. Edison dropped the price from fifty to thirty-five cents in 1904, but cylinders began to lag as his heavily rural market suffered most with the consequences of the economic decline.[152] The argument that cylinders offered better sound also mattered less if prospective customers never compared formats. Instead, attracted by word of mouth or print advertising, they visited only one of the increasing number of dealers who sold Victor products. Furthermore, customers often based choices not only on musical selection, fidelity, or loudness, but for ease of handling the system. For all of the work on improving the phonograph, cueing the stylus on a cylinder required more dexterity and care than on a disc with an ample lead-in groove to the performance.[153]

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[151]Millard, Edison, 195.

[152]Ibid., 200; Gelatt, 159-61.

[153]Millard, America on Record, 129.

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Limited playing time also helped dampen sales of Edison's seventy-five-cent 1906 Grand Opera Cylinders. These featured members of the Metropolitan Opera singing abbreviated arias which did not compare well to the time available on Victor's ten- or twelve-inch discs; the timing of the campaign was equally inauspicious. Edison responded by introducing the Amberol cylinder in October 1908. The same dimensions as his earlier records, Amberols consisted of a harder wax blend to support two hundred grooves per inch where only one hundred had been recorded before. A year later, he revived the Grand Opera market with cylinders of two tenors priced at one to two dollars apiece that could be played on the $200 Edison Amberola. Doubled playing time did not appeal to customers as concerned with convenience as Caruso's reputation, however, and with some of his assistants patenting laterally recorded disc improvements, Edison finally relented and went over to the disc format.[154]

Typically he continued to divide his business as well as his energies. Having finally obtained the right to use celluloid in his records, Edison innovated the fifty-cent "Blue Amberol" cylinder in October 1912. Its high velocity and constant speed in playback, pure hard plastic content, and vertically cut grooves gave the record a sonic reputation that ranges from "far above the general level achieved by pre-World-War-I recording technique" to "a brilliance and clarity that stand out even in the age of

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[154]Read and Welch, 197.

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digital reproduction."[155] With Columbia's exit from the cylinder format in July, the expansion in the number of disc system manufacturers from two to forty-six between 1912 and 1916, and the steady decline of the rural population, however, Edison sold his cylinders to a market of a million-plus players that shrank absolutely and relatively until he left the record business in 1929.[156]

Edison debuted the "Diamond Disc" system in October 1913.[157] The upright players cost from $250 to over $800; the two-sided records, or "re-creations" as Edison termed the performances ran between one and two dollars. These consisted of a powdered blank that changed from wood flour to Chinese clay to a blend of wood flour and chalk powder, bound and coated by rosin and petroleum residue. After pressing, the records received multiple coats of an artificial varnish, condensite. The coating improved the smoothness and durability of the grooves, but each successive layer took longer to dry, up to several hours, and were therefore hardly well suited to

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[155]First quote from Gelatt, 166; second from Millard, Edison, 212. Millard overstates the claims for the blue Amberols by other record aficionados; see the excerpted letter from from one of them, whose ability to hear must have been reduced at the age of eighty-five: 363-64, n. 12.

[156]Gelatt, 165-66, 168, 190, 192.

[157]Gelatt, 167, Millard, Edison, 215; Read and Welch date its production to late 1912: 198-99.

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mass production. With fewer coats and a clay center, Diamond Discs were hygroscopic and tended to warp and split in humid climates.[158]

Edison's new system incurred neither the sales that Edison hoped for or the legal conflicts his lawyers feared. After telling Edison in 1911 that he thought it "one of the greatest misfortunes that you decided to go into the disc business," Johnson relaxed as the Diamond Disc experienced a succession of problems in gaining acceptance.[159] Although Victor's engineers found that the phonograph avoided infringement on the Victrola and that the record was "infinitely better than any other," in Johnson's words, the system still needed marketing by "more progressive people." By 1914 Victor's $16 million dollar output quadrupled that of Edison in the $27 million phonograph industry. The proportions were worse in record production, where, for the industry overall, discs outnumbered cylinders 23 million to three million.[160]

Perhaps a more progressive Edison would have abandoned the rural market and joined Johnson and Easton in catering to the urban middle class. It did not help that he personally evaluated every recording despite his

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[158]Raymond R. Wile, comp., and Ronald Dethlefson, ed., Edison Disc Records and Artists, 1910-1929, special research by Ben H. Tongue (Brooklyn: 1990), 26C, 26H-I.

[159]Quoted in Koenigsberg, lxiii.

[160]Millard, America on Record, 65, quote in n. 2; 133.

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deafness, which perhaps accounted for his confusion of the vibrato effect with that of tremolo and his dislike of both. Nor did he approve of the modern emphasis on celebrity and attendant fees it demanded of producers like himself.[161]

Nonetheless, Edison put his performers to work in marketing his disc system. Two years after the debut of the Diamond Disc, Metropolitan opera soprano Anna Case sang before a jobbers' convention in Des Moines in comparison with her recording on Edison's record. By 1916 the company had standardized the tests, organized sets of performers and sent them on campaigns through the backwaters of Edison's market. The occasional test was held in a Boston or New York concert hall, but most took place in towns like Henryetta, Oklahoma, where Edison's core consumers lived and where few other events distracted from the promotion. Although reviewers were not deceived, many attendees asked for encores from the performers alone, and musicians and singers had no illusions about the naturalness of the recordings or Edison's tastes in performance, the tone tests became a standard promotional tool for any promoter advocating the fidelity of his

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[161]For an extended discussion of Edison's attitudes about musical sound, see John Harvith and Susan Edward Harvith, Edison, Musicians, and the Phonograph: A Century in Retrospect, Contributions to the Study of Music and Dance, no. 11 (Westport, Conn.: 1987), 3-11; for the difference between vibrato and tremolo see soprano Emma Nevada's definitions quoted in Hurst, 98; for an example of Edison's disdain for reputation, see the exchange reprinted in R. Wile and Dethlefson, 5A-6A.

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product.[162] For all of the complaints within the Edison ranks about the musical selection or marketing, however, by 1920, the firm's sales had risen to $22.6 million, or more than forty percent of Victor's gross.[163]

Section XV: To the End of An Era, 1910-1922

For the first quarter of the twentieth century the phonograph business was second only to that for the automobile as the fastest growing industry in the United States.[164] By the 1920s, Victor comprised an enormous plant employing ten thousand people on the Camden riverfront. Half of them assembled cabinets in a six-story building, drawing on the world's largest orders of African mahogany. Hundreds of machinists operated custom-built equipment to fabricate every part of the talking machine down to the stylus.

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[162]Emily Thompson, " Machines, Music, and the Quest for Fidelity: Marketing the Edison Phonograph in America, 1877-1925," The Musical Quarterly 79, no. 1 (Spring 1995): 148, 152-60; Harvith and Harvith, 11-17, and interviews therein with Ernest L. Stevens, Anna Case, Samuel Gardner, and Donald Voorhees. The Ampico Corporation was the first to copy Edison's ploy with its reproducing piano on October 8, 1916, in New York City: Bowers, Encyclopedia, 281.

[163]Millard, Edison, 195; Haddon notebook, Hagley 2069.

[164]Edmund E. Day and Thomas Woodlief, The Growth of Manufactures 1899-1923: A Study of Indexes of Increase in the Volume of Manufactured Products, Census Monographs VIII (Washington, D.C.: 1928), 63, place only the automobile industry ahead of it.

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Women, because of their facility with intricate assembly, built the soundboxes out of metal, glass, and rubber.[165]

Victor's success did not rely on Johnson alone. He was a moderate and rational man, willing to delegate authority when the opportunity presented itself. By 1910 he worked a strict nine-hour day, and spent one month every year on vacation.[166] Part of a generation of engineers turned managers, Johnson established production controls and bookkeeping routines from the birth of the company or before, and left it to his fellow directors to maintain the company.[167]

Johnson's first principle of management was to hire people he trusted to do a job well, based on their background, productivity, and ability to cooperate with their colleagues in the greater goals of the company. Throughout Victor's growth, Johnson relied on men he had known and worked with from the beginning of his involvement with the technology. None of these men could be described as incompetents. For those farther down the ladder who were perceived to have potential, the company

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[165]E. R. F. Johnson, 105-106; Douglass, VI, p. 2, for mahogany orders; Millard, America on Record, 52.

[166]E. R. F. Johnson, 91.

[167] "Notes on Victor, General 1908" and Robert W. Wythes, "Recollections of the Victor Talking Machine Company from 1905 to 1928" (August 1968), and attached examples of four-part material requisition form and three-part forwarding ticket, both courtesy Nicholas F. Pensiero and now part of Hagley 2138.

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sponsored further education.[168] Besides his associates on the board of directors, Johnson kept in touch through visits and correspondence with William Owen, Belford Royal, and Alfred Clark at the Gramophone Company in London and with Douglass in California, where the latter retired after a nervous breakdown in the fall of 1906. Johnson insisted on retaining his marketing savant as chairman of the board and kept Douglass's office open for his annual visits. Louis Geissler, whom Johnson had known as manager of Victor's San Francisco distributor since 1901, replaced Douglass as general manager. Albert Middleton, Johnson's friend and foreman in the late 1890s, became secretary for thirteen years. When Royal quit the Gramophone Company in 1907, Johnson put him in charge of the Zonophone subsidiary and later made him general superintendent of the Victor factories. Royal, once Johnson's foreman, became chairman of the board in 1926. Thomas Parvin served as treasurer for four years with Charles Haddon as his understudy and then directed record manufacturing from 1905 to 1909. Haddon, Johnson's old accounting friend, took over as treasurer and became vice president as well in 1906. Edward E. Shumaker, who started out as stenographer for Victor's first cashier, Albert Atkinson,

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[168]Robert Wythes, who worked at Victor and R. C. A. for fifty years as an accountant, enrolled in three sets of night school courses: "Recollections," [3, 4].

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rose to the presidency of the company in the 1920s, when Johnson's brother-in-law, Edward MacEwan, became secretary.[169]

Victor's success had as much to do with improved marketing and manufacturing practices and integration with American habits of leisure as it did with standardization or quantifiable changes in the sound of the records or phonographs. Johnson's Victor Talking Machine Company made Emile Berliner's laterally recorded discs and players the dominant format despite Edison's efforts to perfect the sound qualities of his cylinders and vertically recorded "Diamond Discs." By the early 1920s Victor had led an oligopoly controlling the production and distribution of records for fifteen years.

Moreover, Johnson exacted maximum benefit from social, technical, legal, and commercial circumstances of the first decade of the twentieth century that made it an opportune time to integrate the disc record into American society. He and his staff exploited the declining length of the average workday and concomitant rise in leisure time and real wages; the integration of the national market through railroad, telegraph, and telephone; the experience of rationalization in other corporations; the lack of legal consensus on the extent of patent protection or copyright for

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[169]Aldridge, 116, for dates of Victor's officers and directors; Douglass, VIII, pp. 1-2, for Douglass; Johnson, "Memorandum," 9, for Middleton; E. R. F. Johnson, 84, for Royal; Notes on Victor Talking Machine Company, General 1905, for Parvin; Douglass, VI, 3, for Atkinson; and Wythes, "Recollections" n. p. [1] for Shumaker.

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mechanically reproduced works; and the fact that in the pre-electric era of home entertainment, he had a product more versatile and less expensive than the alternatives: piano, player-piano, or music box.

Johnson established a staff of "competent experts" in several experimental departments, "each specialized . . . to entirely cover the field of research from which the future improvements on talking machine manufacturing may be dug." He likened the process of innovation to mining, and recognized rather mournfully in 1913 that he presided over a mature technology:

> Improvements come hard now-a-days. The field is no longer a virgin one. Great chunks of free gold are no longer lying around to be picked up by lucky hunters. . . . The old-fashioned prospector is out of the race.

Johnson recognized that he was one of those prospectors. His approach was, in the words of the company historian, "mostly 'cut and try.'" To Johnson, technical improvement arose out of craft skills, like those used in watch or violin manufacture. He predicted it would "take twenty-five years yet to perfect the talking machine." This would involve the accurate cutting of "billions of vibrations so small that the eye can detect but few of them," and "construction of the parts that record and reproduce the sound to a satisfactory volume without destroying its beauty."[170] In this statement Johnson suggested the limits of his understanding of sound--if in those

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[170]Quotes from E. Johnson, "History," 5-7. Aldridge, 47, states that there was only one "costly experimental laboratory."

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vibrations he was referring to the frequency of any audible sound--and of his optimism. Future workers on the problem would continue to build mechanical transducers; the machinist could not imagine the invention of alternatives.

Two trends support Johnson's elegiac analysis. Only seven of his fifty-six patents relating to sound recording and reproduction were issued after 1913.[171] Advertising expenditures rose absolutely and relative to domestic billings, from around four percent in the early years of the company's operation, to an annual average of over eight percent of a larger gross. Much emphasis has been placed on the $40 million spent on behalf of Victor products to explain the company's success, but when Johnson wrote that the "selling organization is the most important and most expensive of the whole establishment," he was also conceding that in a mature, or stagnant, mass-produced technology, consumer demand was more important than innovation.[172]

For all of the investment in the phonograph system between 1900 and 1924, it remained a nineteenth-century technology. To be sure, Johnson protected the commercial supremacy of his company through patented improvements, but he showed no interest in the rapid development of

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[171]"List of Patents Issued to E. R. Johnson," in E. R. F. Johnson, 178-79.

[172]Aldridge, 48-49; Millard, America on Record, 56; E. Johnson, "History," 6.

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electrical science or technology or their possible adaption to his industry. He never referred to electricity in his review of Victor's research in 1913 or his prediction of the future improvements of what, to him, was always a "talking machine." Johnson was, finally, a mechanic, born and raised in the nineteenth century, who realized his vision for the technology shortly after he turned forty. What could he do for an encore? The greatest challenges, as he saw them, lay in overcoming the advantages of an even older system of music reproduction and of the competition while tailoring the business to the preferences of his desired customers. A reluctant hero of industry, Johnson paid little attention to the issue of corporate renewal, either of leadership or technology. Johnson's conception of the evolution of a business accounted in large part for the persistence of presumably outdated business approaches to home entertainment systems, even as another technology offered an alternative path to profit.[173]

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[173]For more on the distinction between nineteenth and twentieth century corporate approaches to technological systems, see Leonard S. Reich, "Industrial Research and the Pursuit of Corporate Security: The Early Years of Bell Labs" in Richard S. Tedlow and Richard R. John, jr., eds., Managing Big Business: Essays from the Harvard Business Review (Boston: 1986), 34-36.

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Part II: From 78 to Microgroove, 1922-1950: The Reconstruction of the Phonograph Record

On June 21, 1948, Columbia Records held a press conference at the Waldorf-Astoria Hotel in Manhattan. On display was a stack of records that played at the speed used for nearly fifty years, seventy-eight revolutions per minute (rpm); it stood eight feet high. Peter Goldmark, director of the laboratories for the parent company, Columbia Broadcasting System, or CBS, carried a fifteen-inch pile of records called LPs containing the same 325 prformances. Although these were the same size as the 78s, they played at 33 1/3-rpm, were made of a vinyl copolymer instead of the traditional blend of shellac and mineral powder, and used a smaller stylus and groove for playback. They had little of the old discs' surface noise and more of the sound generated by an orchestra. Most significantly, they contained up to twenty-five minutes of music on a side, instead of three to five. A twelve-inch LP would retail for $4.85; by comparison, a comparable album of 78s listed at eleven dollars. For playback, Columbia licensed Philco and Magnavox to use its lightweight pickup on two-speed phonographs.[1]

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[1]Roland Gelatt, The Fabulous Phonograph, rev. ed. (New York: 1965), 290; "Columbia's Challenge," Newsweek, June 28, 1948, 82; Goddard Lieberson, "A 33 1/3 Revolution in Recording," The Saturday Review of Literature (heareafter SRL), June 26, 1948, 41; Sally Bedell Smith, In All His Glory: the Life of William S. Paley, the Legendary Tycoon and his Brilliant Circle (New York: 1990), 282. The eleven-dollar album featured pressings on Vinylite; the same album of shellac 78s cost $7.25.

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RCA Victor, the successor to Eldridge Johnson's company, responded with a seven-inch disc that revolved at 45-rpm and was designed with a fast-acting changer to balance continuity of sound with consumer choice of records. Both discs were lighter, more compact, and generally quieter than 78s. Their success in the 1950s fuelled further refinements in sound reproduction and changes in the distribution and sales of records. One result was to make "high fidelity" sound available to a middle-class audience.

These developments represented enormous changes in the technology, business, and culture of sound reproduction from that of a generation before, and therefore raise a series of questions. Why did inventors, entrepreneurs, and consumers reconstruct the 78 as the LP and 45? Why did the LP become associated with high fidelity when its greatest improvement was in playing time, and when consumers not long before indicated their preference for low fidelity sound?

The second half of the study explains how the resolution of one presumptive anomaly--the limitations of acoustic recording--led to the perception of another--the sound reproduction limitations of the shellac-based 78. In the 1920s, the introduction of a new technique in sound reproduction reshaped everything about the record and the participants in its evolution including, ultimately, the record itself. The Depression, the discovery of consumer preferences for low fidelity, World War II, and a

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boom market delayed the resolution of the second one, even as RCA Victor and then Columbia approached the 78 as the basis for another presumptive anomaly. This was the issue of playing time.

There appeared to be nothing wrong with acoustically powered sound reproduction in the early 1920s. Recordists continued to extract incremental improvements, but researchers from other industries began to apply their training in modern techniques of electrical engineering to the problems of sound reproduction. The consequences were dramatic. Electronic amplification of sound resulted in records that reproduced more of the frequencies and dynamism of a live performance with less distortion; to control of the industry by publicly held, multi-divisional corporations; and to organized groups of consumers who commented on the best forms of innovation. Fundamentally, the new techniques of amplification meant that loudness no longer depended on the pressure of the stylus in the groove. But the limitations on sound reproduction caused by the mineral powder in the 78s necesssary for their durability in the old system clashed with the increased sensitivity of recording and reproduction possible with the new.

Here was an example of the solution of one presumptive anomaly leading to awareness of another one. If inventors and entrepreneurs wanted to exploit fully the possibilities of electronic sound, they had to eliminate the abrasive properties of the discs and reduce the weight, wear,

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and distortion of the pickup. It could not have been too surprising that needle scratch concealed a multitude of other sins against the ideal of "high fidelity" that engineers began defining during the Depression. The question was finding the resources to investigate and resolve those flaws in a corporation with other priorities. If the corporation did invest in record innovation, its inventors, marketers, and managers had to decide on the shape as well as sound of the new record. Different formats--an improved 78, a longplaying record, and new record for changers--fulfilled the interests of different constituencies at different times. The further problem involved persuading consumers conditioned to needle scratch that change in any of these formats was an improvement justifying replacement of the older system.

It took nearly twenty-five years for members of the interested parties--inventors, entrepreneurs, and consumers--to converge on resolution of the observed anomalies and improve the record. Much as the two world wars have been likened to one divided by an intermission, electrification and the records of the late 1940s were different parts of the same revolution. They were separated in this case by internal issues like technological lag and corporate restructuring, external events like the Depression and the World War II, and changes in consumer culture that blurred the distinction between the two.

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Despite radical changes in the structures of research, innovation, and consumption, the behaviors of inventors, entrepreneurs, and consumers are similar to those seen during the acoustic era. Decisions and negotiations still required conscious choices on the part of participants. As in the acoustic era, individuals decided if this technology was more interesting than others to work on and improve, if it promised more profit than other products, and if it fulfilled more wants, needs, and desires than current alternatives.

Inventors were now usually members of a corporate team. They arose now from a culture of university training in theoretical techniques that permitted mathematical analogies between mechanical, electrical, and acoustic circuits. Similar training in chemistry increased an interest in replacing shellac in its proprietary blends with more predictable materials. These new languages enabled more sharing of information and teamwork in their new environment of corporate and professional collegiality.

Before one could conceive of an LP or its high fidelity sound, inventors had to merge the electronic techniques of recording and reproduction developed in other industries with a nineteenth-century technology. They had to develop a cheap record material that required no noise-generating additives. They had to quantify the technical relationships within the phonograph system to improve them, and they had to define a "high fidelity" sound that proved acceptable to consumers.

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Entrepreneurs now worked in publicly held corporations where records occupied a much smaller part of the bottom line than in the past. Despite the relative reduction in importance, the existence of the product line and specialized staffs of inventors and marketers created an incentive for middle managers to innovate for the sake of advancement within the corporation or industry. Those running the corporation had less engagement with the technology, but they still acted as much on ego as the search for profit.

Technological innovation continued to be only one aspect of business strategy. Corporate entrepreneurs had to find ways to sell a new sound in the 1920s, to sell records at all in the Depression, and to exploit the best market in industry history during the 1940s--before, during, and after a world war.

Consumers are more difficult to compare, given the paucity of material from the earlier period. The significant differences lie in two trends in the electrical era. First, corporate entrepreneurs developed, or thought they had, a better understanding of what consumers wanted in improvements. Second, subgroups, music lovers and audiophiles, coalesced and became more visibly influential--either in the strategy of one record company or in the outcome of innovation itself. They still had to evaluate the value of older recordings with the revolutionary and incremental improvements in performances that began in 1925. They had to decide just

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how necessary record purchases were to their personal identity and well-being during the Depression. Finally, they had to decide how they defined high fidelity sound, and whether they liked the versions offered by the record companies.

The period 1922 to 1950 marks a significant phase in the history of sound of the phonograph record. Inventors, entrepreneurs, and consumers responded to one another's changing interests to construct new techniques and formats that became standards into the next century. These material developments provided the foundation on which they could conjure the immaterial impression of "high fidelity" from a mass-produced disc of manmade plastic. This part of the study lays out the second stage of the process by which participants shaped the sound they heard from records by shaping the record itself.

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Chapter 4: Electrification Takes Command? Victor Talking Machine, the Phonograph, and the Consumer, 1922-1929

Section I: Introduction

David Sarnoff, a young and visionary executive for the Radio Corporation of America (RCA), could look forward from having witnessed and encouraged the development of radio from code to sound transmission in less than ten years and believe that the phonograph would benefit from radio engineering. Looking back, it appears equally obvious that the techniques and technologies of electronic amplification would be applied to the record and that consumers would embrace the modernity of the application.

The successful improvement of recorded sound in the 1920s did not unfold according to Sarnoff's logic or that of hindsight. The producers, especially Victor, resisted his proposals for justifiable reasons until declining sales drove them to innovate a markedly better sound in 1925. Much of the impetus for resolving the presumptive anomaly of acoustic sound reproduction arose from the inventors and entrepreneurs at AT&T, not those from General Electric who Sarnoff represented. The phone company's system relied on electronics for improved recordings, but also on mathematical calculations that rationalized the enclosed horn Johnson designed for the Victrola. Victor soft-pedaled the nature of the innovation in marketing "Orthophonic" reproduction, and consumers embraced the experience not for the modernity of the system, but for the novelty of the

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sound. The innovation in its electronic incarnation helped spawn a new set of audio buffs who crossed over from the radio hobby. The new sound also spurred the growth of music lovers as an organized group, and their magazine served as a meeting ground for producers and consumers about the technology and music from which they both benefited.

Yet few phonograph owners appreciated the improved capacities of the record. In the last half of the 1920s most contented themselves with discs of varying speed, composition, and production quality made by dozens of entrepreneurs, and played on portable players and the phonographs made by hundreds of companies in the previous fifteen years. If they bought one of the new players, they faced the challenges of its sonic incompatibility with pre-electric discs.

A further reason for the lack of appreciable change lay in the record itself. Despite the revolution in technique, it remained the same nonstandard product it had been for over twenty-five years. In this part of the system, technical, commercial, and cultural reasons all militated against changes in its composition. The development of a quieter record and a lighter transducer and tonearm required materials and mass-production capabilities not yet available. Record entrepreneurs trod a delicate balance between offering a significantly better system and alienating the owners of millions of older records. Nor did the development and sale of improved records offer the profit of a phonograph built to resemble fine furniture,

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particularly in the face of increasingly sophisticated programming by radio broadcasters.

This chapter explains how Americans arrived at the beginnings of a revolution in sound reproduction. By the end of the decade, when Sarnoff orchestrated the purchase of Victor, the prospects for even higher fidelity seemed assured. The next chapter addresses the obstacles to further innovation in the 1930s.

Section II: The Telephonic Origins of Electrical Sound Recording and Reproduction, 1917-1924

At the same time that Eldridge Johnson began selling his enclosed-horn Victrola in the fall of 1906, Lee de Forest invented the audion. This three-element electron tube became the source of better sound recording and reproduction in three ways. It provided a source of undistorted amplified power; a consistency of operation that enabled baseline measurements against which peaks in input or output could be identified; and, in the electrical transduction of sound waves, a new way of representing sound that could be analyzed mathematically. For recordings, these benefits promised to broaden the frequency range and flatten the frequency response, so that the ear heard all sounds recorded, from the lowest notes to the highest, equally loudly.[2]

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[2]Emily Ann Thompson, "'Mysteries of the Acoustic': Architectural Acoustics in America, 1800-1932" (Ph.D. diss., Princeton University, 1992), 267-69, 271-76; for more on the development of the audion, see Hugh Aitken, The Continuous Wave: Technology and American Radio, 1900-1932

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The stimulus for these developments did not arise from advocacy or investment by the leading radio entrepreneur, Guglielmo Marconi, who showed no interest in electronic technologies. Tube innnovation for audio purposes came initially from AT&T's efforts to improve the transmission of sound over telephone wires. To measure the qualities of electrically transmitted sound, AT&T engineers and scientists began developing standard instruments and electromechanical transducers offering uniform response at varying levels of power. These technologies coincided with and enabled the formation of a new science, electroacoustics. This was based on the application of electrical circuit theory to the behavior of sound, an insight which arose in research laboratories and universities across the United States and Europe in the late 1910s and early 1920s.[3]

Between the end of World War I and 1925, several corporate research laboratories developed the rudiments of electrical sound recording or reproduction systems. In particular, Bell Telephone Laboratories engineers led by Joseph P. Maxfield began working on electrical recording of sound on disc in the fall of 1919. This work included specifications for an electromagnetic recording head, with which they recorded performances by

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(Princeton, NJ: 1985), 194-249.

[3]Thompson, 270-74.

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phone line from the Capitol Theater in Manhattan.[4] AT&T also purchased an electrical recording system from Phonic Laboratories in New York City.[5]

For playback, Bell engineers began experimenting with electrical amplification in 1915.[6] They installed a carbon-button microphone in a phonograph soundbox and connected it to the needle and the standard Bell "loud speaking receiver." Several model shop versions provided "good volume in moderate sized rooms and quality which is about as good as that of the ordinary phonograph," although that quality was "not all that may be desired." Demonstrations in the spring of 1921 at president Warren Harding's inauguration and the National Chamber of Commerce convention led to inquiries by Columbia about development of a high-priced electric phonograph for consumers.[7] The Western Electric Company,

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[4]Elmer Bucher, "Radio and David Sarnoff," vol. 2, 310.

[5]Charles [?] Stone to O. D. Young, May 17, 1927, "An Analysis of the Moving Picture Industry and its Relation to our Developments of the Photophone," p. 2, in Owen D. Young Papers, Owen D. Young Library, St. Lawrence University, New York (hereafter Young Papers), box 190, folder 343A.

[6]See liner notes, "Early Hi-Fi: The Beginnings," in Early Hi-Fi: Wide Range and Stereo Recordings Made by Bell Telephone Laboatories in the 1930s, Leopold Stokowski Conducting the Philadelphia Orchestra, 1931-32 (Bell Telephone Laboratories sound disk, 1979), also vol. 2 by the same title (1980).

[7]E. H. Colpitts to F. A. Ketcham, June 2, 1921, AT&T Archives, Warren, New Jersey (hereafter AT&T Archives), Charlesworth Record Group, box 16, folder: "Phonographs, 1921-1927."

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AT&T's manufacturing arm, responded, and a little over a year later, Western Electric's chief engineer organized demonstrations of such a phonograph to manufacturers.[8]

By 1923 the company had developed electromagnetic pickups for reproduction through tube-amplified loudspeakers.[9] Did they provide better sound? One firm reported that it used the "entirely satisfactory . . . tonal qualities" of its model phonograph as a standard for tests of its acoustic phonographs. On the other hand, George Lyle, the phonograph company president who had attended the demonstration, suggested that the "electrical reproducer" would gain large demand for use with "dance records" and thereby avoid the "same criticism . . . as there would be by attempting to use it with vocal records."[10]

Lyle's comment helps explain the challenge facing the AT&T managers. Manufacture of the electric pickups was still a craft as much as a technique. Production would be labor-intensive, limited, and expensive, and the market necessarily directed at the more affluent adult and sedentary

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[8]George F. Lyle, Manufacturers Phonograph Company, to Edward B. Craft, August 17, 1922, AT&T Archives, idem.

[9]Bucher, "Radio and David Sarnoff," vol. 2, 310.

[10]First quote from Henry Orsenigo, The Orsenigo Company, to P. M. Rainey, Sales Development Manager, Western Electric, August 5, 1924; following quotes from Lyle to Rainey, September 19, 1924, both in Charlesworth Record Group, box 16, folder: "Phonographs," AT&T Archives.

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population that preferred popular and operatic songs over band instrumentals. Unless the manufacturers marketed the phonograph with batteries, it would also be limited to the fifty-three percent of American households with electricity in 1925.[11]

Even as Western Electric struggled to adapt an old technology to a new technique, Bell Labs researchers were developing the science behind "taking sound from the air, storing it in some permanent way and reproducing it again without appreciable distortion." In a paper they presented at the Midwinter Convention of the American Institute of Electrical Engineers in February 1926, Maxfield and Henry C. Harrison explained for the first time a system of "high quality recording and reproducing" based on explicit assumptions, quantifiable data, mathematical ratios and analogies of physical behavior, and test by controlled experiment. It marked a revolution in improving the sound of records by laying out the basic principles by which research and development have been practiced ever since, and therefore deserves some review.[12]

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[11]Electrification percentage from Ben Wattenberg, Statistical History of the United States (New York: 1976), cited in David E. Nye, Electrifying America: Social Meanings of a New Technology (Cambridge, MA: 1990), 395, n. 50.

[12]J. P. Maxfield and H. C. Harrison, "Methods of High Quality Recording and Reproducing of Music and Speech based on Telephone Research," Transactions of the American Institute of Electrical Engineers (hereafter TAIEE), XLV (1926): 334-46, and "Discussion," 346-48; for the significance of this article, see Thompson, 275, and her citation of Harry B.

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Harrison and Maxfield first examined the issue of what the listener heard from a record. Unlike their predecessors, from Edison to Eldridge Johnson, they defined phonographic perfection. It occurred "when the components of the reproduced sound reaching the ears of the actual listener have the same relative intensity and phase relation as the sound reaching the ears of an imaginary listener to the original performance would have had." Without two channels from the sound source to the listener's ears, it would be "very difficult, if not impossible" to provide the necessary sense of location in space of each sound source. But the engineers found that they could "simulate to a considerable degree . . . the space relationships of the original" music through control of the acoustics in which recording took place. The reflection of sound off room surfaces and the varying times of reverberation depending on the location of the sound sources within the room gave the record listener "a sense of spatial depth." Building on Wallace Sabine's research for ideal reverberation times for live performances, they experimented to find the ideal for recordings.[13]

With this approach, Harrison and Maxfield initiated the field of psycho-acoustics, in which perception was as important as the phenomenon. While other companies, Victor included, intuitively made

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Miller, "Acoustical Measurements and Instrumentation," Journal of the Acoustic Society of America (hereafter JASA) 61 (February 1977): 277.

[13]Maxfield and Harrison, "Methods," 334-35.

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reverberation part of their recording process Edison had rejected this approach. His recordings, in which he attempted to capture only the direct sounds of an instrument and not its reflections, indicated his desire for a direct reality, even in sound reproduction.

When they moved from the recording space to the recording and reproducing system, Maxfield and Harrison recognized the frequency characteristic as the most important requirement at "the present state of the art." This comprised the relationships between intensity and frequency on the one hand and phase distortion versus frequency on the other. Because they concluded that their system was "relatively free . . . from violent phase shifts," the pair concentrated on the former. There, the task of capturing all frequencies at a given power input with equal sensitivity had already been accomplished by E. C. Wente's development of the condenser microphone.[14]

The challenge with the disc record lay in choosing between mechanical, electrical, or electro-mechanical approaches, and choosing what was appropriate in each step based on technical, commercial, and cultural limitations. Maxfield and Harrison used microphones and electrical amplification to record an orchestra because crowding around a horn broke with traditional structures, and "with such an arrangement of musicians, it

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[14]E. C. Wente, "Condenser Transmitter as a Uniformly Sensitive Instrument for Mearsuring Sound Intensity," Physical Review 10, no. 1 (July 1917): 39-63.

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is very difficult to arouse the spontaneous enthusiasm which is necessary for the production of really artistic music."[15] Recording supervisors had to limit the expression of that enthusiasm by restricting the amplitude of lower-frequency soundwaves at a given intensity to prevent overcutting of adjoining grooves. Otherwise, too much space between grooves shortened playing time to an unreasonable amount. At some higher velocity the radius of the curvature of the soundwaves became too small for the stylus to track. Raising the speed of the groove to overcome this inherent limitation also shortened playing time. One alternative was to record at a lower intensity and make more sensitive reproducing equipment, but this was was negated by the presence of "'record noise' or 'surface noise'" which was "already loud enough in comparison with the reproduced music to be somewhat objectionable."[16]

Electrical reproduction offered the option of compensating electronically for the roll-off from a flat frequency response at the low and high ends of the range recorded, but Harrison and Maxwell chose to retain a mechanical system. In this choice, it appears that they argued disingenuously, as the business among the corporations controlling RCA

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[15]Maxfield and Harrison, "Methods," 336.

[16]Ibid., 335.

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limited AT&T's sale of electrically based entertainment.[17] To avoid conflict with General Electric or Westinghouse, they posited that the power generated by the record was sufficient to transmit "the necessary sound intensity" in the home. An electrical system would require a transducer above the stylus to convert mechanically generated soundwaves to an electrical analog, and another at the loudspeaker to convert them back. The extra frequency response was not worth the "complications of amplifiers, power supply and associated circuits."[18] Thus consumers would hear the distortion of the electrical recording for the time being while the engineers could anticipate "the commercial possibilities of further improvements."[19]

With these parameters in place, Harrison and Maxfield proceeded in 1922 to draw on twenty years of telephone research on sound amplification, transmission, and reception to construct their system. They used Wente's

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[17]The interpretation of the phone company's right in the field of electronic home entertainment varied between 1922 and 1926, depending on who in the corporation wanted to press the company's claims. AT&T limited its manufacturing subsidiary, Western Electric, to the sale of equipment "for the mechanical reproduction of sound from phonograph records." The emphasis is in the original: W. S. Gifford to C. G. Dubois, June 29, 1925, in AT&T Archives, box 51 microfiche, "W. E. -- Patent Licenses to Gramophone Co. Ltd.–1925, 1926." Nearly twenty years later, an article on Bell Labs explained the improved acoustic phonograph was developed in deference to likely public reluctance to buying electronic phonographs: "'Bell Labs': Its Philosophy is the Telephone," Radio, May 1942, 58.

[18]Maxfield and Harrison, "Methods," 337.

[19]Ibid., 338.

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microphone and amplifier, numerous papers on electric wave filters, and the work of three mathematicians to calculate and test the analogies between electrical and mechanical circuits in the recording and reproducing systems.[20] In this respect the role of "radio" or the vacuum tube was almost incidental, or only instrumental in providing the means by which the phonograph could be improved. In early 1923 Harrison began filing patent claims on aspects of a mathematically optimal acoustic phonograph amplifier, which included a concentrically corrugated diaphragm in the soundbox and an exponentially tapered horn.[21] With Maxfield, he designed the stylus link to avoid infringing on Victor Talking Machine's patents and the horn to fold into a standard phonograph cabinet without noticeable unwanted resonance.[22] By early 1924 they had a demonstration system that

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[20]See the citations in ibid., 338, n. 6, and the gratitude expressed to E. L. Norton, P. B. Flanders, and A. L. Thuras, 339, n. 7, and 346, n. 14.

[21]H. A. Burgess to J. G. Roberts, March 26, 1925, AT&T Archives, Charlesworth RG, box 16, folder: "Phonographs, 1921-1927."

[22]J. C. R. Palmer to D. C. Tanner, March 23, 1923, AT&T Archives, Charlesworth RG, box 16, folder: "Phonographs, 1921-1927"; Gelatt, 220-23. See also E. W. Kellogg's comments on the lack of justification for Maxfield and Harrison's design after they delivered their paper to the Midwinter Convention of the American Institute of Electrical Engineers: Maxfield and Harrison, "Methods," 348.

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offered marked improvements in sound quality and quantity over the leading Victor records and phonographs.[23]

For the transmission of perceptible sound, an ideal frequency range "with relatively uniform intensity" would cover from sixteen to ten thousand cycles per second (cps). This included the subsonic notes of a church organ and the harmonics of the notes of various musical instruments. Maxwell and Harrison managed to record, with "slightly deficient" low and high ends, one hundred to six thousand cps. Their mechanical phonograph reproduced a range from 115 to four thousand cps. This was wider in range and flatter in response than that offered by one of the best Victrolas, whose response curve started with less intensity at 240 cps, peaked three times, and and dropped off around 3,500 cps. The Bell researchers could have increased the response at the high end but for the concomitant increase in surface noise generated by the mineral powder in the record.[24]

The whole process marked a revolution less in technology than in method. Two workers at the Hawthorne works of Western Electric had

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[23]Gelatt, 223.

[24]Maxfield and Harrison, "Methods," 335, 336, 343 fig. 14, 344, 346 fig. 20. The authors claim in the text that they could obtain frequencies as low as sixty cps, as depicted in the calibration curve in fig. 14. Closer examination of this curve suggests they used an uneven standard to measure the drop-off from a flat response.

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found that applying the corrugated bakelized linen diaphragms used in the company's loudspeaker horns to phonograph soundboxes gave "wonderful, simply wonderful" reproduction, and they urged the company to sell the diaphragms directly to the country's five or six million phonograph owners.[25] At the Laboratories, Harrison and Maxfield developed the corrugated diaphragm independently and explained why it improved reproduction significantly compared to mica or glass diaphragms.[26]

The difference in their approach marked a change from empiricism, the old science of documented cut and try, and the new science that blended theoretical design with experiment. Other men had tinkered with electrical recording, and re-entrant horns had been standard in phonographs since Eldridge Johnson debuted Victor's in 1906.[27] Victor's chief engineer, S. T.

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[25]Quotes from John G. Casey and J. R. Clark, "Suggestion for Improvement of Value to, or for Betterment of the Company or its Employees," no. 2000, December 26, 1922; C. G. Stoll to E. B. Craft, January 18, 1923, both in Charlesworth RG, box 16, folder "Phonographs," AT&T Archives.

[26]E. B. Craft to C. G. Stoll, March 31, 1923, Charlesworth RG, box 16, folder "Phonographs," AT&T Archives. The corrugation expanded the area of the diaphragm, which helped improve the frequency range, within a practically constricted space; the corrugations had to be spaced to keep the resonant periods of the flat surfaces above the perceptible frequency: Maxfield and Harrison, "Methods," 344, 345.

[27]For a review of the many electrical recording experiments before 1925, see Michael Jay Biel, The Making and Use of Recordings in Broadcasting before 1936 (Ph.D. diss., Northwestern University, 1977), 114-19, 264-309.

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Williams, admitted later to the exhaustion of the old method of research and development. In mechanical sound reproduction, "[a] complete theory connecting the great series of disjointed facts was still lacking. Development along empirical lines had reached its utmost and the art of sound reproduction had come practically to a standstill in its progress."[28]

Despite the pleas by the Hawthorne employees to sell Western Electric innovations directly to the public, AT&T was not structured to do so. The company struggled to sell home radio equipment profitably, and the phonograph companies already had factories and distributors through which the new technology could be made and sold.[29] But AT&T's executives could not assume that winning over the caretakers of the established technology was an accomplished fact. Victor Talking Machine,

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[28]S. T. Williams, "Recent Developments in the Recording and Reproduction of Sound," Journal of The Franklin Institute 202, no. 4 (October 1926): 416-17; also quoted in Gelatt, 220. Raymond Sooy refers to him, entry for April 27, 1925, in "Memoirs of My Recording and Traveling Experiences for the Victor Talking Machine Company," copy provided by Nicholas F. Pensiero and now deposited in the Hagley Museum and Library as part of Hagley 2138, "Files of Nicholas F. Pensiero." B. L. Aldridge, The Victor Talking Machine Company (Camden, NJ: 1964), lists G. T. Williams in Appendix XII, "'Key' Personnel," 115. Aldridge is reprinted, four pages to one, in Ted Fagan and William R. Moran, eds., The Encyclopedic Discography of Victor Recordings (Westport, Connecticut: 1983).

[29]In June 1925, Western Electric's comptroller estimated that the company had lost $450,000 on nearly $12 million worth of sales of radio equipment between 1920 and 1924 when development costs were factored in: R. H. Gregory to C. Uhrig, April 8, 1925, AT&T Archives, box 51, microfiche: "Analysis of W. E. Radio and Loudspeaker Sales--1925."

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the leading phonograph company, remained the creation of Eldridge Johnson, who saw little need for the electrification of sound or cooperation with the purveyors of the new sound.

Section III: Eldridge Johnson, the Victor Talking Machine Company, and the Sources of Technological Conservatism

On June 7, 1922, David Sarnoff, vice president and general manager of the Radio Corporation of America (RCA), went to the Hotel Commodore in New York City and gave an informal speech to the conventioneers of the National Association of Music Merchants. Despite the poor quality of sound emanating from the home radios flooding the market, Sarnoff argued that "fundamentally" the radio was a "music device." As such, he suggested, "it may ultimately approach the phonograph . . . I believe we are moving in the direction of a combination instrument." He therefore proposed that "we electrical fellows . . . improve your musical business by improving the quality of your reproduction. People learn to accept things as they are, of course, but none of us are [sic] really satisfied with the present phonograph. . . . I am told that what comes out of [a] phonograph represents in quality less than 15% of the original voice." Electronic innovation could raise that percentage; conjoined to his listeners' marketing experience, the potential of

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innovation led Sarnoff to conclude that "Radio and the Music Industry are natural allies."[30]

No one recorded the response to Sarnoff's speech, which echoed a memorandum he had written two months earlier, but he told the dealers and distributors what they wanted to hear.[31] Whether they dealt in phonographs or pianos, the merchants continued to suffer from a glut of discounted products in the aftermath of the postwar boom and the 1921 depression. By contrast, home radio had burst onto the mass market in the last six months. Barely regulated, crudely programmed, and noisily reproduced, radio entertainment portended to be little more than a fad. To hear RCA's vice president speak of technical improvement in measurable terms suggested that their salvation lay in aligning themselves with the nascent consumer electronics industry. That Sarnoff was only thirty-one years old reinforced the vitality of, and hope in, the technology he represented.

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[30]"Informal Address Delivered Before the Convention of the National Association of Music Merchants," June 7, 1922, Hedges Collection, file 132, 1922D: "David Sarnoff," Library of American Broadcasting, University of Maryland, College Park, Maryland (hereafter LAB).

[31]"Radio and the Phonograph Industry: A Few Fundamentals," April 10, 1922, Hedges Collection, file 132, 1922D: "David Sarnoff," LAB; reprinted in Elmer E. Bucher, "Radio and David Sarnoff," typescript vol. 2, 310-2, in David Sarnoff Library, case 14, Princeton, New Jersey (hereafter DSL); edited version in David Sarnoff, Looking Ahead: The Papers of David Sarnoff (New York: 1968), 37-39.

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For Eldridge Johnson and the board of Victor Talking Machine, however, the need for better sound was not clear at all. Business for the country's largest phonograph and record producer was very good. Despite the astonishing sales of home radios in the previous six months, Sarnoff showed nerve in asserting the superiority of a product subject to unpredictable sound and content. After fifteen years of choosing their own entertainment and listening to the tone of the Victrola, consumers knew and enjoyed what they heard from records. Besides, promotional claims aside, no one believed that phonograph sound and real sound were interchangeable. Needle "scratch" and the distortions that defined phonograph sound were part of the price paid for the miracle of reproduction. The fact that Victor's records of shellac and mineral powder easily outsold Edison's smooth-surfaced Amberol cylinders and Condensite discs indicated that sound quality was not a consumer priority. If we look more closely at the state of the record in the early 1920s, it becomes apparent that Johnson had legitimate commercial, technical, and cultural reasons for resisting electronically-based innovation. Later writers have ignored these in portraying the phonograph industry as unable to react appropriately to revolutionary change.[32]

In the first place, between the postwar depression of 1920-21 and 1925, Victor enjoyed excellent sales in terms of dollar and unit volume. After a

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[32]Gelatt, 216-17, 220, 223-24; Millard, America on Record, .

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forty-three percent drop to 320,860 phonographs sold in 1921, the company saw a substantial recovery. Overall unit sales rose the next three years, although cheaper portable players for the consumer touring by automobile constituted about a third of the increase.[33] At the same time, record sales in 1920-24 marked the best years in company history, despite a switch to double-faced Red Seal records in 1923 that halved sales in the premium trade.[34] Most importantly, Johnson and his board looked at Victor's rising bottom line and saw no reason to change the company's formula for success. Net profits climbed from the 1918 trough of wartime production, and outside of the boom years of 1915-16, earnings reached successive all-time highs in 1922 and 1923.[35]

This pattern did not stem from a strategy of stagnation. Victor continued to enjoy substantial profits in a mature and increasingly

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[33]Aldridge, Appendix IV, 109; Michael Brian Schiffer, The Portable Radio in American Life (Tucson, AZ: 1991), 64-65.

[34]"Comparison: Records vs. Instruments (Units), Victor, RCA, and RCA-Victor 1901-1944," VTM/RCA/GE Collection, Hagley Museum and Library Accession 2069, Historian series, box 9, folder 46 (hereafter cited as Hagley 2069). Aldridge's figures for Victor phonographs are more specific: Appendix IV, 109, and are reprinted in Robert W. Baumbach, Look for the Dog: The Victor Talking Machine Companion (Woodland Hills, CA: 1994, fourth printing), 8. For the Red Seal conversion, see Sooy, "Memoirs," entry for May 1, 1923.

[35]J. & W. Seligman & Co., "An Analysis of Victor Talking Machine Company," (New York: [1928]), 17, in Young Papers, Victor file, box 149, folder 11-14-74.

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competitive industry after many basic patents expired during World War I through continued innovation in sound recording and styling.[36] Despite the appearance of technological stasis, various individuals pushed forward with improvements in sound. Johnson's pessimism about improving reproduction notwithstanding, when the recording department was "successful enough to make an improvement then comes the fight to hold that standard and try for one better." Staff members vied with one another to develop the most sensitive recording diaphragm by tinkering with the linkage between stylus and mica sheet and the rubber cushioning fixing the mica to the soundbox. Between 1896 and 1925, Victor engineers developed at least 350 soundboxes. Other engineers and mechanics refined the wax composition used for recording and the electroplating process by which stampers were made. The result was that, over time, Victor and other companies increased the recordable frequency range, particularly for the harmonics that identified stringed instruments. Recording groups could use double basses instead of tubas, and, on occasion, real violins, not the metal Stroh model.[37]

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[36]Aldridge, 86; Gelatt, 189-90.

[37]Sooy, "Memoirs," entry for March 12, 1898; Gelatt, 203. For the number of soundboxes, see "Miscellaneous Items for Display on Cherry Hill," in Hagley 2069, Historian's series, box 2, folder 68: "'Hall of Progress' Display, 1954-55."

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The staff also concerned itself with room acoustics. In moving the New York "Laboratory" in 1921, Harry Sooy and company "found it necessary to have the interior of the room changed considerably before obtaining satisfactory results."[38] Two years later, Sooy had the #2 recording room draped with Monks Cloth "to break resonance," which "proved beneficial."[39] Where a generation before Berliner and Johnson had been limited to soloists for fearing of overcutting the grooves, Sooy recorded 2,500 voices at the Billy Sunday tabernacle on New Year's Day, 1917. Later that year, responding to the development of orchestral recording in Europe, Harry Sooy arranged a similar accomplishment in Camden. He started in July with fifty-one musicians under Victor's musical director and scaled up to eighty in September. Satisfied with the results, Victor booked Karl Muck and the Boston Symphony Orchestra the following month.[40] The company released three discs as a result, which elicited the critical comment that the records' "precision, phrasing, and tone are equaled only by the balance and

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[38]Sooy, "Memoirs," entry for January 6, 1921.

[39]Ibid., entry for December 12, 1923.

[40]Ibid., entries for January 1, July 23, September 21, and October 2-5, 1917.

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clarity. . . . There was never anything like them before, and there can never be anything like them again."[41]

The craft of sound quality extended to evaluation as well. One song by Paul Whiteman's Orchestra required twenty-two takes before everyone involved could agree on "a satisfactory master record." Rachmaninoff replayed his Prelude in C Minor thirteen times. In this case, as in others, the cause of the problem "was unexplainable."[42] Even as Victor's recording staff increased the number of recordings made from 2,690 to 6,746 between 1910 and 1917, they reduced the percentage of discs approved for sale from sixty to forty-three percent. In 1919 the company formalized this process through a Record Testing Committee that met to evaluate every week's recordings and "maintain the highest musical and mechanical standard possible."[43]

Victor's commitment to sound quality led to applications beyond entertainment. One "recording experimentalist" worked on "Government Experimental Recording" research between 1915 and 1918. The Aviation Corps called on the company in 1917 to develop a system for testing the hearing of applicants. After leaving a prototype with the corps, Sooy and his

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[41]Ronald D. Darrell, quoted in Gelatt, 214.

[42]Sooy, "Memoirs," entry for December 13, 1921.

[43]Ibid., entry for December 31, 1917; quote from January 1, 1919.

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staff continued to refine the record-based technology, finding it "proved to be very accurate."[44]

The result of the focus on quality of recording was improvement in the quality of sounds reproduced. Twice in the years between 1901 and 1922 the company rerecorded "a big portion" of the catalog in order to bring the quality of older performances to the standards of contemporary recordings.[45] During the winter of 1916, Victor introduced the "Tungs-tone" needle, which had the advantages of wearing without significantly damaging the record grooves. Advertising trumpeted its improvement in tone reproduced as well as its durability, but not the fact that the innovation came from GE, which licensed the fabrication technique from its innovation of tungsten filaments for lightbulbs.[46]

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[44]Ibid., entries for March 16, 1914; and October 30, November 26, 1917.

[45]Ibid., entries for June 1 and 12, 1919; March 12, 1922.

[46]Albert G. Davis to Owen D. Young, March 27, 1925, Young Papers, box 149, folder 291. Davis to Young, February 4, 1927, idem, mentions a letter Davis sent to Victor "with reference to phonograph needles," but the copy is not in the file. See the Victor version in Aldridge, 75; Eldridge Reeves Fenimore Johnson, His Master's Voice Was Eldridge Reeves Johnson (New Milford, Del.: 1974), 102; and James N. Weber, The Talking Machine: The Advertising History of the Berliner Gramophone and Victor Talking Machine, edited by Eric Skelton (Midland, Ontario: 1997), 100. For more on Victor needles, see Ron Pendergraft, "Victor's Tungs-tone and Fibre Needles," Victrola and 78 Journal 6 (Late summer 1995): 1-7 (hereafter V78J); and Tom Rhodes, "More on Needles," V78J, 8.

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As for styling, the senior Johnson insisted on retention of the tall mansard-style Victrola cabinets after World War I. Notwithstanding changes in interior decoration that favored functional, period furniture designs, Johnson feared that the broader, flat-topped cabinets coming into vogue and sold by Brunswick and Sonora would encourage the phonograph's use as a table, thus deterring record playback and purchases. It is not clear that his adamance about public taste harmed business. Unit sales declined sharply in the depression of 1921, when Victor sold only 12,300 new "humpbacks," cabinets with a raised lid in the center, compared to 243,600 standard phonographs. By the next year, Victor revised production so that sales totals were nearly equal before swinging better than two to one in the humpbacks' favor in 1923. These changes took place within increases in overall phonograph sales each year from 1922 through 1924.[47] Record sales in those years also justified Johnson's design tactics, as Victor enjoyed its second, third, and fifth best years in unit sales of discs.[48]

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[47]Dane Yorke relates the humpback's flaws as an example of Victor's decline in "The Rise and Fall of the Phonograph," The American Mercury, September 1932, 9-11, and states that the company responded with flattops only in 1924 after watching net operating income plunge 80% in two years. See also Gelatt, 212. Millard bases his similar evaluation of decline on secondary and vaguely dated sources: America on Record, 306, n. 75. Johnson acknowledged his responsibility for the humpbacks, ibid. Sales figure from Aldridge, Appendix IV, 109.

[48]"Comparison: Records Vs. Instruments (Units), Victor, RCA, & RCA-Victor, 1901-1944," Hagley 2069, Historian's series, box 9, folder 46.

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When compared to the record industry as a whole, Victor's management had even greater cause for confidence. In 1921 dealers sold records at a dollar volume that would not be matched again until the inflationary years after World War II. In the first half of the 1920s, however, sales fell steadily at an annual rate of 13.5 percent and by 1925 totalled $59 million, or just over half of the $106 million total four years before.[49]

This decline cannot be attributed exclusively to the rise of home radio. The number of phonograph manufacturers exploded between 1914 and 1921 from eighteen to 250, and as demand for luxury items collapsed in the 1921 depression, so did phonograph production. As a result, dealers dumped merchandise on the market at cost for the next two years, while a postwar excise tax of five percent added to the costs of manufacturers trying to stay solvent. The swelling interest in portable machines available for automobile trips also lowered the average unit price of phonographs.[50]

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[49]Stephen Traiman, "The Record Industry in the United States," Journal of the Audio Engineering Society (hereafter JAES) 25, no. 10/11 (October/November 1977): 786.

[50]Gelatt, 208; he gives somewhat conflicting numbers for manufacturers on 190. I have interpolated his figures with those gathered by R. J. Wakeman in "263 Machines and Their Makers: 1916-1923," V78J 10 (Winter 1996): 2-21, and online at www.garlic.com/~tgracyk/makers.htm, visited January 29, 1999. For the effect of the depression, see Wakeman, "263 Machines," 5-6; Paul Israel, Edison: A Life of Invention (New York: 1998), 454; and Johnson's letter to stockholders in the Victor Talking Machine Company Annual Reports for 1921-24, American Heritage Center, University of Wyoming, courtesy of Raymond R. Wile; for the impact of the portables, see Baumbach, 92-94; Weber, 115; and Israel, 455.

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The growth of record labels almost matched that of phonograph producers. In February 1921, the Starr Piano Company won in court against Victor the right to make laterally cut discs, setting a precedent that some 150 companies exploited within a year. What had been a trickle of cheap small-diameter discs featuring anonymous and obscure performers in the late 1910s became a flood of ten-inch records pressed of cheap shellac blends and sold in department stores at three for a dollar or twenty-five cents apiece. Licensing agreements with European companies enabled some labels to compete with Victor's Red Seal artists at a significant discount.[51]

A considerable portion of responsibility should also be assigned to the declining interest in the record industry by the entrepreneurs who founded it. The Columbia Phonograph Company, long the second leading producer of disc records, had been unstable at least since 1911, when founder Edward

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[51]William M. Randle, "History of Radio Broadcasting and its Social and Economic Effect on the Entertainment Industry, 1920-1930" (Ph. D. diss., Western Reserve University, 1966), 318-20; Rick Kennedy, Jelly Roll, Bix, and Hoagy (Bloomington, Ind.: 1994), 23-27; Allan Sutton, "America's 'Little Record' Fad," V78J 9 (Summer 1996): 39-43; Sutton, "A. C. Gilbert and the Bob-O-Link Record," V78J 8 (Spring 1996): 18-19; Sutton, "The Cameo Record Corporation," V78J 10 (Winter 1996): 29-31; Sutton, "The Emerson Phonograph Company," V78J 12 (Winter 1997-1998): 39-45; Sutton, "Sorting Out Puritan: An Investigation of Paramounts's Sister Label," V78J 13 (Autumn 1998): 68-71; Sutton, "A Red Seal by Any Other Name," V78J 9 (Summer 1996): 44-5.

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Easton tried to sell the company to Edison.[52] After Easton died in 1915, the company suffered at the hands of a Wall Street financier. As a result of overcapitalization and the 1921 depression, the share price rose from 65 to 300 before plummeting to 15/8 in four years. In October 1923, Columbia went into receivership after defaulting on $15 million worth of loans.[53] The introduction of a silent surface disc developed by its English subsidiary, Louis Sterling's Columbia Gramophone Company, in 1922 did not stem the tide of red ink, and Sterling bought the company in 1925.[54]

Business at Thomas A. Edison, Incorporated, was little better. Sales of Edison's vertically cut "Diamond Disc" phonographs and records peaked in 1920, just as smaller companies switched to lateral recording with the court decision on the Victor-Columbia patents. The founder responded to the depression the following year with a series of questionable layoffs, prompting remaining staff to seek job security elsewhere. Edison never built a portable phonograph or cut corners on production costs in order to match the widespread pricecutting; his advertisements continued to emphasize how he had "perfected the phonograph." The technical

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[52]"A Proposal Made in 1911 to Consolidate Edison and Columbia," introduction by Tim Gracyk, http://www.garlic.com/~tgracyk/columbia.htm, visited January 29, 1999.

[53]Yorke, "Rise and Fall," 7-9; Gelatt, 210-11; Aldridge, 83; Randle, 320.

[54]Read and Welch, 212; Aldridge, 91.

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isolation, loss of management continuity, and Edison's enduring disconnection with mass market tastes in music or sound sent record sales into a permanent decline. From a high of 7.6 million records sold to jobbers in 1920, Edison sales comprised only two percent of the market seven years later.[55]

While the original labels suffered from the senescence of their leadership, new companies entered the market ready to experiment with new approaches to home entertainment. The experience of Brunswick Balke Collender as the leading second generation phonograph and record company is the best example. Run by the son-in-law of the founder, Brunswick began diversifying from billiard tables into phonograph production, among other products, during the boom of the 1910s. Benjamin Bensinger began selling quality phonographs at sixty percent of industry prices while using the "Ultona" pickup that could play both vertically and laterally recorded dics. More than any other company, Brunswick was responsible for making phonograph a generic term for disc record players. In 1920 Brunswick moved into record production primarily because Bensinger disliked seeing other companies' records on his machines. It responded to dance music enthusiasts' demand for more bass sound by building phonographs with considerable cabinet resonance, a successful

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[55]Andre Millard, Edison and the Business of Innovation (Baltimore: 1990), 294-301; Gelatt, 209; Israel, 454-56, quote on 456.

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innovation Victor engineers derided as "barrelly" or "tubby" in reproduction. Two years later Brunswick won a couple of patent suits over Victor and became Johnson's leading competitor.[56]

In response to Brunswick's strategy of growth by compatibility with the established labels' catalogues, Johnson retaliated. After he lost the infringement suits, in 1922 he ordered his staff to develop an automatic brake at the end of a record's playback that required an elliptical groove leading out from the performance. All other disc records, whether vertically or laterally cut, ended with a concentric spiral. When played on Victor phonographs, these discs would no longer activate the brake mechanism, thus running down the springwound motor. Sooy worked with the phonograph engineers on coordinating the change in the disc with that in the mechanism, and by 1923 began applying the new groove to old master

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[56]Rick Kogan, Brunswick: The Story of an American Company from 1845 to 1985 (Skokie, Illinois: 1985), 3, 38-42; Eugene Lyons, David Sarnoff: A Biography (New York: 1966) 145; Gelatt, 217; Aldridge, 91; Marco, ed. Encyclopedia of Recorded Sound, s.v. "Brunswick," "Brunswick-Balke-Collender Co;" R. J. Wakeman, "Brunswick Enters the Phonograph Field," V78I 9 (Summer 1996): 2-6; idem, "The Ultona Arm and Reproducer," V78I 9 (Summer 1996): 7-8; idem, "Brunswick Records: The Early Years," V78I 11 (Summer 1997): 14-21, and at www.garlic.com/~tgracyk/ early.htm, visited January 29, 1999; idem, "Brunswick Phonographs and Records," www.garlic.com/~tgracyk/brunswick.htm, visited January 29, 1999; idem, "The Brunswick-Victor Legal Battles," V78I 12 (Winter 1997-98): 22-25. It is not clear that the inventor of the Ultona, Louis Taxon, worked for Brunswick. The company's tone arms were manufactured by the General Phonograph Corporation, which also sold them to other manufacturers: Wakeman, "263 Machines," 2; "The Ultona," 7.

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recordings that Victor continued to issue.[57] The difference in leadout grooves remained an annoyance for every listener using a Victor phonograph to the end of the spring-motor era.

Even without Brunswick's challenge, Victor's managers had some commercial incentive for broadening the company's product line. The value of radio sets and components manufactured rocketed from $9.5 million in 1921 to nearly $156 million in 1924. Within that growth, however, there existed radical annual cycles of change in the technology, manufacturing, and sales.[58] For that reason members of that industry alternately craved and feared Victor's entrance. In Nipper, Victor possessed one of the best-known trademarks in the United States. In 1924 Victor spent five million dollars for advertising, including over one billion full-page ads in newspapers and magazines, or more on the print media than any other

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[57]Sooy, "Memoirs," entries for August 30-31 and December 2, 1922; May 1 and July 3, 1923. My thanks to Dr. Michael Biel, Morehead State University, for explaining the nature of the incompatibility.

[58]Radio statistics are from the Census of Manufactures, cited in Jana Lyn Hyde, "Adversaries to Allies: The Radio-Recording Industry Relationship, 1920-1950," (Ph.D. diss., University of Alabama, Tuscaloosa, 1994), 63. For a review of annual changes within this period through 1927, see the report by Cornell, Linder, & Co., The Radio Industry, (New York: 1928), 72-87, copy in DSL, case 15, and Yorke, "The Radio Octopus," 386-68, 390-92. W. Rupert MacLaurin, in Invention and Innovation in the Radio Industry, (New York: 1949), overlooks the commercial competition in this period for the patent license competition in the following decade in Chapter VII, "The Perennial Gale of Competition, 1928-1941," 132-52.

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corporation.[59] A Victor product connoted quality and service, and promised to lend that cachet to an industry haunted by fly-by-night operations. It also threatened to rob other companies of sales.

Yet Victor's management felt no little ambivalence over diversifying its offerings for home entertainment. The board of directors, most of whom had worked with or for Eldridge Johnson since the turn of the century, represented some two hundred years of experience in the acoustic phonograph industry. Their response to the new technology's impact on their culture and business comprised a mix of incomprehension, fear, and loathing. New staff were warned informally to avoid the subject of radio in 1924.[60] This attitude manifested itself in the company's approach toward home radio. In 1922, general superintendent George W. Smith ordered two engineers to build fifty four-tube radios, which were installed in the

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[59]For Victor advertising see Yorke, "The Radio Octopus," 394, and "The Rise and Fall," 11. For the billion pages, see Gelatt, 224. In 1915 Victor was the fifth largest advertiser in magazines: Daniel Pope, The Making of Modern Advertising (New York: 1983), Table 2.5, 45. Eldridge Johnson's son reported a conversation between his father and William Wrigley, jr., founder of the chewing gum company, in which it appears the latter spent $14 million on advertising to Victor's $4 million. It is not clear whether Wrigley's sum was an annual or total expenditure: E. R. F. Johnson, 103.

[60]Yorke, "The Rise and Fall," The American Mercury, 12; Gelatt, 223-24.

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cheapest Victrolas for trademark protection in the new industry.[61] The following year, Victor hired physicist Carlton D. Haigis to build a radio chassis around the radio trust's patents. Haigis failed, as did negotiations with the Wireless Specialty Apparatus Company to buy receivers when it transpired that Victor would have to deal with RCA because of cross-licensing and marketing agreements. In December 1923, the company even gained a license for a hundred-watt broadcast station from the Department of Commerce but never put it into operation.[62]

Efforts at Victor to adjust to the rise of radio as a form of home entertainment were desultory, first because of the company's continuing success, and second because of the quality of sound and programming in the new medium. Despite the existence of radio communications for twenty-

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[61]"News and Views: R. J. Tullar Retires," Engineers Digest, (RCA) May-June 1952, 42, Sarnoff Corporation library, Princeton, New Jersey; Tullar, a mechanical engineer from M.I.T., and Walter Bloom built the receivers. Baumbach, 120. Morgan E. McMahon, ed., Vintage Radio: Greenwood's Historical Album Expanded, 2d ed., (Palos Verdes Peninsula, CA: 1973), 67, shows an undated faceplate for a Victor crystal set, which may have been produced by another company.

[62]Aldridge, 86; for Victor's overtures to Wireless and its purchase of a radio license, see Bucher, 365. Bucher claimed that the Wireless Company's limited patent rights ended discussions. For the Wireless Company's corporate and contractual ties, see Hugh G. J. Aitken, The Continuous Wave: Technology and American Radio, 1900-1932 (Princeton, New Jersey: 1985), 446-47; for Victor's inability to design around the basic radio patents, see Yorke, "The Radio Octopus," 394. For the year of Haigis's hire, see Alfred Goldsmith to O. B. Hanson, January 8, 1932, NBC Papers, Central Files: Correspondence, box 10-C, folder 16: "Goldsmith, Alfred 1932," State Historical Society, Madison, Wisconsin (hereafter NBC Papers).

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five years, the transition to continuous wave broadcasting compounded the variety of ills from which radio reception suffered. First among these was static. Generated by variations in the atmospheric electric fields, the erratic nature of static made it that much more distracting than the constant needle scratch on records. Static also arose from manmade sources; the operation of electrical motors as well as other radio transmitters interfered with reception. Atmospheric changes also contributed to signal fading.

Within the sets themselves, crystal set receivers provided no amplification of a signal, and the vacuum tubes that did contributed a background hum when static was not present. Batteries ran down, requiring regular recharging and raising the consumer's electric bill. Unscrupulous dealers sold used vacuum tubes to the unwary. Tuning with the regenerative circuit generated squeals, or "birdies." The result was such that Edison, having first given station WJZ one of his disc phonographs and some records, asked it to stop using his system on the air in the fall of 1921, complaining that "if the phonograph sounded like that in any room, nobody would ever buy it."[63]

These were problems on the receiving end. Radio transmission added its own difficulties. Those included the numerous stations operating

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[63]Quoted in Eric Barnouw, A Tower in Babel: A History of Broadcasting in the United States, vol. 1--to 1933 (New York: 1966), 84, and at greater length in Biel, 221-22. For more on radio reception in the 1920s, see Susan J. Douglas, Listening In: Radio and the American Imagination (New York: 1999), 68-78.

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on the one wavelength initially permitted for broadcasting and changes in the power of transmission at nightfall. These stations also operated at different power levels, which meant that listeners were "blasted" by more powerful broadcasts as they switched from one station to another. As for programming, when a station could not attract live performers of erratic ability, it played phonograph records through a horn directed at the microphone. In all, as RCA engineer O. B. Hanson recalled, the combination "produced a form of complex distortion that one can barely think of today."[64] While these problems had not deterred consumers from adding nearly three million radios in two years to the sixty thousand in use in 1921, by February 1924, they also provoked a spirited discussion of the problem of radio sound among RCA's board of directors.[65]

The phonograph was, by comparison, a fully developed technical, business, and cultural system. Within that system, Victor had an established tradename that connoted a certain level of quality control of the record, if not the recording. Despite the name of the company, its staff took seriously the notion that the phonograph was a musical instrument. As

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[64]Quoted in Randle, 67.

[65]Radio set statistics from Radio Retailing, cited in Brookmire Economic Service, Inc., "Brookmire Special Reports: The Radio Industry," A 299, December 2, 1930, Table I, in Young Papers, box 149, folder 291A. For RCA's internal debate, see Albert G. Davis to Gerard Swope, February 11, 1924; J. G. Harbord to Davis, March 3, 1924; Davis to Harbord, March 5, 1924, in Young Papers, box 87, folder 223R.

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such it offered a sound that, while distinguishable from a live performance, was nevertheless euphonious in its own right.[66] Radio sound was a phenomenon to be ridiculed, not respected. Between 1922 and 1924 several record labels, including Victor, issued records that parodied the overlapping stations and noises that made listening so unpleasant.[67]

Nonetheless, the company could not ignore the potential application of vacuum-tube amplification to their industry. This was particularly true for recording, and while Edison rejected any innovation involving vacuum tubes, Brunswick, Columbia, and other companies did not. At Brunswick, Benjamin F. Miessner contracted to develop electrical recording in December 1920. Eleven months later, Miessner demonstrated his recordings of a soprano, a pianist, and an orchestra to music critics of the Chicago newspapers and reporters from the industry magazines. He went on to develop electrical reproduction, a radio/phonograph console, an equalization circuit, and a sound level meter, all of which remained with Brunswick after he left in mid-1922.[68]

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[66]See Marsha Seifert, "Aesthetics, Technology, and the Capitalization of Culture: How the Talking Machine Became a Musical Instrument," Science in Context 8, no. 2 (1995), especially 437-40 and 443-47; and Aldridge, 47-56, 67.

[67]Biel, 243-50; E. R. F. Johnson, 112-13, wrote that the Victor disc, released in 1924, sold "like the proverbial hotcakes."

[68]Biel, 272-74. Brunswick never received patents on Miessner's work.

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At Columbia, after a change in management in the spring of 1922, the company invited Lionel G. W. Guest and Horace O. Merriman to develop their electrical recording techniques in the company's New York studio. This pair had patented such a method early in 1920 and in November made the first commercial electrical recording, of the burial of the Unknown Soldier in Westminster Abbey, for Columbia Graphophone, Ltd. They spent nearly eighteen months improving on the poor sound of their English disc before Columbia went bankrupt and closed out the project in November 1923.[69]

A much smaller laboratory, run by Orlando Marsh, began experimental electrical recordings in 1923. The following year Marsh organized the Autograph record label featuring "an entirely new system of recording . . . representing ten years of experimental and research work." Despite aural evidence that Marsh used microphones and electrical amplification, his records did not specify the type of recording until after Victor and Columbia announced their conversion.[70]

Johnson's wishes to the contrary, individuals at Victor also responded to the potential for technological change. Albertus Hewitt and James W. Owen began recording electrically at Victor in December 1913, and applied

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[69]Ibid., 264-46, and 268-70 for other experimenters during this time.

[70]Allan Sutton, "Recording Becomes Electric: The Birth of Electric Recording in the United States (1924-1928)," V78J 11 (Spring 1997): 32-33.

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for a patent on electrical recording and reproduction three years later. Early in 1922, Hewitt renewed his work, and in June 1922 he began recording radio broadcasts using an audibility meter for volume control.[71] In December 1922 GE's research staff loaned Victor one of Charles Hoxie's Pallophotophones. This recording system included the Pallotrope, a light-modulated microphone, and the Photophone, a variable-area film recorder. Hoxie visited Camden to hear the results of Hewitt's work with the Pallotrope on disc, met with Eldridge Reeves Fenimore Johnson, only son of the founder, and George Smith, the plant manager, and arranged to send improved components from Schenectady.[72]

In January 1923 Hewitt received Standing Order #4006 to "Do experimental work in Broadcasting." This included more recording work, during which he developed another recorder to use with a Western Electric amplifier and a radio from the United States Navy. The standing order on

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[71]Biel, 275-76. Reference to Victor research on electrical recording is made in "Experiments of Owen and Hewitt," Experimental and Research Department, Victor Talking Machine Company, August 24, 1926, courtesy Raymond R. Wile. Gelatt claims that Victor did not experiment at all, 220.

[72]Biel, 283-85. Biel draws on Hewitt's work journal for the early 1920s, which was in the RCA library in Camden and which was not transferred to the Hagley Museum and Library with much of the RCA Camden collection in 1992. For more on Hoxie and the pallophotophone, see Donald Crafton, The Talkies: American Cinema's Transition to Sound, 1926-1931, (New York: 1997), 52, and f.n. 71, and Douglas Gomery, "The Coming of Sound: Technological Change in the American Film Industry," in Tino Balio, ed., The American Film Industry, rev. ed. (Madison, Wis.: 1985), 245-46.

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broadcasting was stopped in July, possibly when Eldridge Johnson returned from one of his melancholic absences, asserting to Victor's board that recent sales declines stemmed more from the general recession than radio. Hewitt resumed work on live electric recording through microphones two months later while his brother, also a Victor employee, worked on techniques at home.[73]

The problem was that Victor's program, if it can be called that, lacked direction and commitment. It is not clear to what end Hewitt worked. After Owen died in June, he apparently worked alone, one of the isolated "Victor inventors who were tucked away in cubby holes here and there." Nor did Victor's staff upgrade itself to the demands of the new techniques of sound engineering. Even in 1929, at the founding of the Acoustic Society of America, Victor had only three members, compared to four at the American Piano Company, nine at RCA, and thirty-four at Electrical Research Products Incorporated.[74] Progressive research and development, and its integration with the company's strategy, depended on Johnson's pronouncements, the board's interpretations of his wishes in his absence, and confusion over

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[73]Biel, 277-79; E. R. F. Johnson, 112.

[74]Biel, 277; E. R. F. Johnson recalled the Victor research establishment in the early 1910s, 99; Thompson, Table 1, "The Acoustical Society of America Charter Member Affiliation, 1929," 335-36. In Victor's defense one should note the absence of either Edison or Columbia staff from the rolls, and the fact that General Electric, the designer and builder of the radios that RCA sold, had only five members.

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what was legally possible in the midst of the radio trust's patent monopoly. Was Victor to invest in radio broadcasting, radio reception, electrical recording, electrical reproduction, or all of the above?

The instability of Victor management compounded the differences in aural aesthetic and notions of home entertainment. Johnson suffered his first bout of melancholia in 1907. He was incapacitated again in 1917-18, 1921, in 1923, again in 1924, and finally in January 1925, after which Johnson never returned to the Camden headquarters.[75] There were two consequences to the founder's psychic instability, one being the loss of Johnson's own mechanical talents. He received the last of his fifty-six individual patents in 1921. As his son put it, "suddenly in 1922 he stopped inventing."[76] Second, without the president's involvement in the development of the company's products, Hewitt and rest of the engineering staff lost their linkage to upper management and concurrently any sense of technical direction or momentum.

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[75]For the first episode, see Johnson's 1907 diary in Eldridge Reeves Johnson Papers, Dover, Delaware, and American Historical Center, University of Wyoming, Laramie (hereafter Johnson Papers); for that and later incidents, E. R. F. Johnson, 89-91, 105, 112, 114; for 1921, R. J. Wakeman, "Brunswick vs. Victor: The Legal Battles," V78J 12 (Winter 1997-98): 24; for 1924, Gelatt, 224.

[76]E. R. F. Johnson, 178-79, 88.

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The lack of direction crippled the company. The quality of electronically transmitted and amplified sound was bad, but the quantity of demand for it and the competition for sound quality inherent in radios indicated that the rising number of university-trained electrical engineers would improve electronic sound. Taking the long view, Johnson might have realized that the improvement, if not perfection, that he foresaw as possible in 1913 using "scientific methods" and "the best equipment" were coming in less than the generation he predicted.[77]

Instead, because of his depression and unwillingness to delegate management of the company, his son, 24-year-old Fenimore, and two executives tried to make sense of the conflict between Johnson's animus toward radio and the changing state of the technology and the market. They discussed with GE vice president A. G. Davis the possible purchase of radio receivers while reviewing the patents surrounding GE's Pallotrope sound recorder. On December 28, 1923, Victor's general superintendent, George W. Smith, and Fenimore Johnson, vice president, met with RCA's vice-

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[77]Eldridge R. Johnson, "The History of the Victor Talking Machine Company," typescript dated February 1913, p. 7, Sarnoff Corporation Library vertical files, Princeton, New Jersey, and reprinted in Mrs. Eldridge Reeves Johnson, comp., "Eldridge Reeves Johnson(1867-1945): Industrial Pioneer," (1951); Gelatt, 84; Aldridge, Appendix xiv, 118; and E. R. F. Johnson.

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president, David Sarnoff, about combining the sound and services of radios and phonographs.[78]

The young executive had been waiting for this opportunity. Well aware of developments in electrical phonography, Sarnoff knew that sound recording and reproducing technologies at Bell were licensed commercially through Western Electric, not RCA.[79] RCA had to look to its majority shareholder, General Electric, for the innovations Sarnoff wanted for the centralized form of home entertainment that he envisioned.

GE had not ignored the phonograph. Paul Fortin of the Switchboard Engineering Department had been working on electromagnetic phonograph pickups since November 1912, and it was probably his handiwork that RCA's staff adapted to demonstrate the possibilities of electrical sound reproduction.[80] Yet having a lab prototype was not the same as having the cooperation of its developers. GE's research departments were no more interested in supporting Sarnoff's interest in phonographs than they were in

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[78]Bucher, 366.

[79]That is, the RCA cross-licensing agreements with AT&T applied to tube-amplification of sound only: Aitken, 435-36. Lyons, 94, refers to this distinction in relation to the future conflict over broadcasting, as does Archer, History of Radio to 1926, 256-57, who cites the contract clause under "Wireless Telephony." There is a photograph of Sarnoff looking critically at the Pallotrope in David Sarnoff Library photo collections.

[80]Biel, 129-34.

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aiding RCA's licensing staff with radio circuits. With Sarnoff's approval in early 1923, then, RCA chief engineer Alfred Goldsmith appointed Lazarus Shapiro to develop an example of the combination Sarnoff had in mind. Shapiro's three-man team combined an RCA radio with a Victor phonograph which was adapted to electromagnetically amplified sound from pickup to Victor's acoustic speaker. The project ran behind the matter of resolving production problems surrounding the superheterodyne tuning circuit for the 1924 home radios, but once completed, it remained only to demonstrate the hybrid's qualities to Victor's management.[81]

Presumably Sarnoff, then thirty-two, spoke knowledgeably and aggressively about the electrical future of sound reproduction to the younger Johnson and the Victor board member, both of whom had lived in an ethos and technology of acoustically reproduced sound. Sarnoff explained RCA's interests and offered to demonstrate Goldsmith's prototype at his home in Mount Vernon, New York. It took nearly two months to arrange this meeting, during which time word got back to Sarnoff that the directors in Camden could not bear to combine their musical instrument with an "electrical gadget." He was infuriated, and ordered the lab to build a combination based on a Brunswick cabinet. Brunswick's management

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[81]Tom Lewis, Empire of the Air: The Men Who Made Radio, (New York: 1991), 169; Herman E. Reeber to Ed Dickey, November 20, 1979, in RCA R&D folder, courtesy of Nicholas F. Pensiero, now part of Hagley 2138. Reeber was one of the other team members.

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responded with more alacrity to Sarnoff's overture, a group travelling from headquarters in Illinois to New York to examine the blend of old and new technologies.[82]

The Victor demonstration finally took place on February 19, 1924. Accounts diverge as to what happened next. According to one writer, Fenimore Johnson wrote Sarnoff two days later, agreeing to contract for the joint production of such combinations. Perhaps the fact that Brunswick was also negotiating with RCA spurred Victor management to respond more quickly. After Victor received three of the "Victor Radiolas" and a draft contract from RCA, however, management changed its mind. While Brunswick signed its agreement March 1, nine days later Victor sent a letter to Sarnoff asserting that the new receivers failed to meet the company's standards for performance and that the contract terms were unacceptable.[83]

Fenimore Johnson recalled events differently: "No agreements were made." He and Smith toured Lee DeForest's plant in Jersey City and met with Western Electric's president Frank B. Jewett for a demonstration of Maxfield and Harrison's sound system, "picking up bits of knowledge here and there but . . . not making any actual progress toward filling the

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[82]The GE talks and the dates are from Bucher, 365-66; the resistance by Victor, Brunswick negotiations, and quote are from Reeber to Dickey, p. 2. The chronology represents my resolution of these sources.

[83]Bucher, 367-68.

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company's needs in the electronic field." This was not cause for alarm yet, in spite of another radio boom that year that Eldridge Johnson believed did harm phonograph and record sales. Nonetheless, despite his acknowledgment of the improvements made to radio, it remained "a flash in the pan."[84] Radio as an alternative was coming, but the quality of reception--of sound much less programming--was not as good as Sarnoff and other enthusiasts believed. Even as Brunswick and other phonograph companies added radios to their product lines, from the Victor perspective there continued to be good reasons to keep the new sound technology at arm's length.[85]

The company did so for months. During this period Raymond Sooy made the "trick record" based on similar discs issued by Victor's British partner, The Gramophone Company.[86] It marked the last attempt by Victor to exploit acoustic recording before the engineers of Bell Labs and Western Electric began installing electrical recording equipment. It also represented the desperation of management in the face of declining sales, occurring as it

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[84]Quotes from E. R. F. Johnson, 112-13; Gelatt, 223.

[85]R. J. Wakeman, "Continuation of the Brunswick Story: The Company Responds to Radio," V78J 12 (Winter 1997-1998): 27-28. Sonora and Pathé also added radios to their lines: see Randle, 323, and Ronald J. Putz, "John Herzog: A Tribute to a Phonograph Manufacturer," V78J 7 (Winter 1996): 19.

[86]Sooy, "Memoirs," entry for January 15, 1924; Sherman, 139. Emile Berliner marketed the first such disc in England in 1898: Koenigsberg, lxx.

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did four months after Victor announced the release of double-sided classical records. In this smaller, more expensive market, Victor had held out for years against offering two performances on one disc, since the concession would discount profits significantly and detract from the cachet of the Red Seal discs.[87]

In the face of rising consumer demand, Victor announced in May 1924 a fall line of phonographs with a compartment for the installation of a radio of the customer's choosing, explaining that the choice would enable buyers to upgrade the radio if they desired.[88] On June 3, under pressure from their distributors and dealers for receivers suitable for installation in the phonograph cabinets, Victor sent a telegram to RCA. The company had been unable to develop a radio to meet its own standards, and now offered RCA and other "reputable" manufacturers the opportunity to install their products in its cabinets. Here again Victor demonstrated a lack of confidence in Sarnoff's approach. Suppliers were to arrange installations directly with Victor dealers, using instructions provided by Victor's engineers. Because of problems with cabinet resonance, such an arrangement implied a wide

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[87]Gelatt, 154.

[88]Gelatt, 217. Gelatt reads an "unabashed condescension" in the announcement, but given the rapid technical and industrial changes in radio at the time, Victor was justified in promising "the best features of radio prosperity without becoming liable to the worst features of radio depression."

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variation in the quality of installation and consequently of sound reproduction. The agreement applied only to radio, not the phonograph, meaning that the console would need both a loudspeaker for the radio and a horn for the record player.[89]

It was hardly surprising that Sarnoff replied negatively within the week on technical and commercial grounds.[90] After enduring Victor's behavior during the winter, he told an RCA engineer that the executives at Camden would have to beg him if they ever wanted to do business with the Radio Corporation. The nearly three thousand $215 Radiola IX receivers designed for insertion in phonographs that RCA marketed in 1924-25 went to Brunswick, which had contracted for $1.5 million worth of radio products.[91] Victor instead produced special versions of certain models and arranged with other radio companies to build fitted receivers.[92]

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[89]Bucher, 368-70.

[90]Ibid., 370.

[91]Reeber to Dickey, p. 3; Hagley 2069, "Feature Display Annotations" in "Significant Features" notebook (1957), Historian's series I, box 1, folder 27, Hagley 2069; Kogan, 46-47; Baumbach, 234.

[92]Zenith Radio and the Colin B. Kennedy Corporation both advertised Victor-compatible receivers: Wakeman, "Continuation of the Brunswick Story: The Company Responds to Radio," V78J 12 (Winter 1997-1998): 28.

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Convinced that broadcast radio was a passing fad of inferior sound and amateur production compared to what one could obtain from the phonograph, Johnson never shared Sarnoff's enthusiasm. At the end of October 1924, he saw only a minimal relationship between the radio and record in combination sets, but these would "always be but a small fraction of either business." Although he did not ignore the new technology, Johnson foresaw extended legal conflicts over patents, little interest by consumers in preselected music when they could make their own choices at home, and no advantage in sound quality. "If the radio ever gets straightened out . . . the Victor Company will be greatly benefited," he explained. He had no intention, however, of turning Victor into a radio company.[93]

Section V: Improving the Sound of Music on Disc, 1924-1925

In September 1924, Victor's phonograph sales failed to rise for the fall season for the first time in company history.[94] That year RCA introduced the highly sensitive superheterodyne receiver in a cabinet resembling one for a phonograph, with antenna, batteries, and speaker concealed, as well as cheaper tabletop models. AT&T's 26-station and RCA's shortwave network

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[93]"Comments of E. R. Johnson, Pres., Victor Talking Machine Co. on Phonographs & Radio In Oct. 29th issue of The Phonograph and Talking Machine Weekly," Young Papers, box 92, folder 223S; partly quoted also in Gelatt, 217. For Johnson's comment on patents, see E. R. F. Johnson, 113.

[94]Aldridge, 86.

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coverage of the presidential campaign provided the content that boosted sales for RCA and other radio companies.[95] The combination apparently ruined the final quarter of the year for phonograph industry, which counted on the run up to Christmas for over fifty percent of its sales.[96] As inventory backed up, nearly half of Victor's wholesalers went out of business or sold out their franchises.[97] Early in December, the company laid off over 8,500 employees, excepting those in the record pressing department and the main office. Net profits dropped over eighty percent to $1.2 million. Over the winter, rumors abounded that management was negotiating with Henry Ford and other automobile manufacturers to sell the plant.[98]

This collapse can not necessarily be attributed to the radio. In 1925, RCA and the rest of the radio industry also suffered. Broadcasting was entering its fifth year, and the "survival-of-the-fittest stage was now at its most acute phase." Until then it had not been clear whether radio was more

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[95]Cornell, Linder & Co., 82-84 and Chart VII; Barnouw, A Tower in Babel, 148-53.

[96]See the pie chart for monthly sales from the June 1919 Talking Machine World reprinted in Wakeman, "263 Machines," 5.

[97]"The Victor Situation," The Talking Machine Journal, February 1925, 86, in Young Papers, Victor Talking Machine Company file, box 149, folder 11-14-74.

[98]J. & W. Seligman & Co., 17; "Victor Company Plans a Surprise," The Journal of Commerce, April 22, 1925, n.p., in Young Papers, Victor Talking Machine Company file, box 149, folder 11-14-74.

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than a fad. By 1925, executives in the radio trust feared that the losses of the many station operators were leading to their withdrawal or bankruptcy. As the number of broadcast outlets declined, so too did public interest and demand for new sets.[99] In RCA's case, unit sales plunged twenty percent from 370,043 in 1924 to 296,050 in 1925, compared to Victor's thirty-seven percent fall from 411,000 to 262,000.[100]

The sales declines in 1924 and 1925 in part could also be attributed to the introduction of the two-sided "Red Seal" classical discs in September 1923. Victor followed Columbia in putting recordings on both sides of its popular black-label discs in 1904. Brunswick forced its hand for classical recordings when the Chicago company began issuing double-sided records for its premium Gold label in the spring of 1922. Putting two songs from the premium Red Seal label on one record cut profits for Victor but not for the singers, whose contracts specified a specific royalty per song. The prospect of paying double royalties on one disc, selling the new records at discounted prices compared to the total for two single-sided records, and reimbursing

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[99]Archer, History of Radio, 364, 369-70; quote on 364.

[100]B. L. Aldridge to T. J. Bernard, November 20, 1946, Hagley 2069, Historian series, box 2, folder 63. In a chart he developed in 1945, Ben Aldridge listed RCA's unit sales drop as thirty-two percent from 800,000 to 550,000: "Comparison: Records vs. Instruments (Units), Victor, RCA, and RCA-Victor 1901-1944," same series, box 9, folder 46. This seems to include tubes used by other manufacturers in their sets. Aldridge's figures for Victor phonographs are more specific: The Victor Talking Machine Company, Appendix IV, 109.

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dealers for their single-sided inventory all discouraged the change in format. The end of the single-sided Red Seal halved the number of discs sold in that fractional but pricey portion of the market, helping drop disc sales by twenty percent in 1924 and another twenty-two percent in 1925.[101]

A look at consumer purchases and leisure activity in this period indicates the relative unimportance of radio to most consumers. At the end of 1925, 10.5 million households, or forty-four percent, had a record player compared to the five million, or nineteen percent, that had a radio. A survey of the population of Muncie, Indiana, as an average American community in 1923-24 found that less than nine percent of surveyed households owned a radio. People who did not buy records for their phonographs reported spending the money instead on their children's music lessons or purchase of a radio; yet the surveyors noted the purchase of only one radio as well as one phonograph. Most family applied their incomes toward automobiles and electric appliances. At this point, radio

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[101]Aldridge, 85-86; "Comparison: Records vs. Instruments, 1901-1944," Hagley 2069, Historian's Series VI, box 9, folder 46; [Eugene F. Haines], "Memorandum: Double Facing Red Seal Records," March 21, 1923, same series, box 2, folder 27; B. L. Aldridge to Roland Gelatt, February 29, 1956, p. 2, regarding page 154 in The Fabulous Phonograph, same series, box 2, folder 61; R. J. Wakeman, "Brunswick Records: The Early Years," V78J 11 (Spring 1997): 20.

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merely vied with the phonograph, automobile, and motion picture as a form of entertainment.[102]

Whether or not the content and fidelity of radios were responsible for the sudden decline, standing pat on sound reproduction marketing, format, or quality had unravelled as a strategy. Despite the efforts of its tiny research staff, Victor would have to buy its way into electronic sound for radio and phonograph. On January 27, 1925, the day Eldridge Johnson left his Camden office for the last time, Joseph P. Maxfield appeared at Camden to begin setting up another demonstration of Bell Labs' equipment.[103]

It appeared that Victor had little to offer in return for access to the AT&T patents. The transition to electrical recording reprises the story of a newer, more quantifiable technique replacing an older one based on qualitative evaluations, and of modern, efficient corporate raiders overwhelming doddering family proprietors committed to an outdated

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[102]National statistics from RCA Research Bureau, in David Sarnoff, "Radio in Relation to the Problems of National Defense," address to the Army Industrial College (February 20, 1926), David Sarnoff: Papers vol. 2, "Flying Torpedo" binder, DSL, case 12; Robert S. Lynd and Helen Merrell Lynd, Middletown: A Study in Modern American Culture (New York: 1929), 172, 244 n. 35, 263-71, 514-17 Table VI. The Lynds cite a Literary Digest study that showed fifty-nine percent of homes in twenty-six cities had phonographs in 1925: 244 n. 35. Diffusion in the South was even lower: see Kenney, 129.

[103]Aldridge, 86-88; Gelatt, 224; E. R. F. Johnson, 114. In Appendix XII, "'Key' Personnel," 115, Aldridge lists a J. C. English in "Experimental;" four men in "Engineering," including the G. T. Williams cited in n. 13 above; and two in "Record Mfg." Curiously, he does not include Albertis Hewitt.

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technology.[104] This was not entirely true, and Victor's general superintendent George W. Smith probably deserves much of the credit. In Johnson's absence, he directed two engineers to build the radios in 1922 in order to protect the Victor trademark in that line.[105] In 1923, he probably approved the hiring of Haigis in an effort to design a radio around the RCA patent pool.[106] It also seems likely that he approved collaborating with Westinghouse on matched impedance research independently of the work at Bell Laboratories.[107]

When Victor began negotiating with Western Electric, Smith directed the engineering department to build an exponential horn loudspeaker, based on Haigis's calculations. Smith concealed the phonograph in the Victor auditorium where the Western Electric team set up its system, and at the demonstration in early February played the same record on the Victor machine. The sound quality did not match that of Harrison's phonograph, but it was close enough that Smith, Fenimore Johnson, and purchasing

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[104]See Reese Jenkins, Images and Enterprise: Technology and the American Photographic Industry, 1839-1925 (Baltimore: 1975), 4-5; Leonard S. Reich, "Industrial Research," 55-56, for a model and case studies of the "business-technology" mindset as an impediment to technological change.

[105]"New and Views: R. J. Tullar Retires," 42.

[106]Alfred N. Goldsmith to O. B. Hanson, January 8, 1932, NBC Papers, Central Files, Correspondence, box 10-C, folder 16: "Goldsmith Alfred 1932."

[107]Aldridge, 87.

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agent Edward E. Shumaker were in a position to reduce the licensing fee significantly. They completed contracts in March, including rights to buy radio receivers from Western Electric.[108]

Simultaneously, Victor's executives negotiated with RCA for licenses to radios and GE's electrical reproduction technology. Here too Victor enjoyed leverage for several reasons, despite Sarnoff's awareness of their financial straits.[109] That spring the radio group was embroiled in negotiations with AT&T to keep the latter out of the home radio business. A legal opinion had thrown out a draft agreement between the parties at the same time Victor contracted with Western Electric. AT&T's radio network had also arranged, first with Brunwick in December 1924, and then with Victor in the new year to broadcast, for free, concerts of their most popular singers.[110]

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[108]For the demonstration at Victor, see E. R. F. Johnson, 115-6; for the month of the contract, see Gelatt, 225; for the inclusion of receivers, see Archer, Big Business, 207. Johnson's date of May 21 for the Western Electric contract refers to the revision after he signed with RCA on May 16. Victor issued its first electrical recording in April.

[109]Owen D. Young to Eldridge R. Johnson, February 6, 1925; [E. R.] Fenimore Johnson to Young, February 12 and 16, 1925; and Sarnoff's forwarding to Stewart Crocker and Owen D. Young a marked clipping of "The Victor Situation," The Talking Machine Journal, February 1925, all in Young Papers, box 149, folder 291.

[110]For the Brunswick and Victor concert series, see "Victor Company Plans a Surprise," The Journal of Commerce, April 22, 1925, n.p., in Young Papers, box 149, folder 291; Randle, 326; Biel, 323-33, 345; Wakeman,

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RCA and its backers thus faced the prospect of world's leading laboratory in sound communication selling radios of superior fidelity, the placement of those radios in Victor phonograph consoles, and Victor's recording stars providing content for the listeners of those radios. Because of Victor's trademark and its massive manufacturing capacity, both the telephone and radio groups regarded the future of the phonograph business as crucial. Sarnoff handled the AT&T and the Victor negotiations simultaneously. He shuttled between convincing the former to give up a lucrative system and market and the latter to switch to RCA as exclusive provider of radios, all the while fending off rumors among RCA's board members of the phone company's acquisition of Victor.[111]

Johnson and Shoemaker spent the better part of the spring in New York at RCA's expense, eating, drinking, and fencing with Sarnoff over licenses from GE and Westinghouse. Even if they were unaware of the broader developments threatening RCA's position as the soul source of radio circuits and tubes, the fact that Sarnoff wanted Victor to cancel the pertinent provision of the Western Electric contract added to their position in negotiating a license fee. So too did the early response in record sales

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"Continuation of the Brunswick Story," 30; and ad reproduced in Weber, 118.

[111]See Albert G. Davis to Owen D. Young, April 1, 1925; Davis to Young, April 20, 1925; and L. V. Morrison to Young, April 22, 1925, in Young Papers, box 149, folder 291, for examples of RCA's and GE's concerns, as well as Archer, Big Business, 207-15, 229-30; Archer, History, 361.

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stemming from the broadcast concerts. As a third bargaining chip, Victor's engineers had developed a loudspeaker for electrical reproduction using a folded-paper diaphragm. Louis Lumière of France patented the technique several years after Eldridge Johnson bought an interest in his company in 1907. Owen and Hewitt had tried it for sound recording in the early 1910s, but its appearance seemed too cheap for Victor machines. Hewitt adapted it as a radio speaker in 1922 with "very good results." When adapted to the RCA superheterodyne radio three years later, it offered markedly better sound than the traditional horn. The trio finally settled on May 16, and five days later Fenimore Johnson signed the revised contract with Western Electric.[112]

Section VI: Selling Better Sound, 1925-1929

Having committed the fate of the company to a new sound, the Victor management now had to sell it. If this transition to electricity represented the arrival of the phonograph industry at the threshold of modernity, because of its link with electronic home entertainment of radio, the irony can not be exaggerated. With three reproduction systems available, Victor emphasized production and marketing of what its engineering staff understood best: the acoustically powered system. Not that the company lacked for choices. It had licensed three options for

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[112]E. R. F. Johnson, 90, 116; "Experiments of Owen and Hewitt;" quote in Biel, 342; idem, 326-27, 330-31; Archer, History, 361; Randle, 326. The date of the contract is from a letter in Archer, Big Business, 230 n. 1, 245.

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reproduction of the new electrical recordings: Bell's acoustic system and two electrical alternatives from RCA. The latter offered the most promise in terms of undistorted frequency range, and Haigis and his staff were skilled enough to work on them, but manufacture would have entailed coordination with GE and RCA's staff as well as significant changes in production methods. Victor could not afford the delays Brunswick encountered with its GE-based phonograph while confronting overhead losses of $500,000 a month.[113]

How did one sell an old product with a new sound? First, Victor had to clear out its inventory. Through the summer of 1925, Victor organized campaigns aimed at unloading old phonographs, and then old records. Late in April, Eldridge Johnson came out of seclusion for the last time to rally the company's Philadelphia dealers, insisting that "come what may, the company would never cut prices."[114] Less than four months later, his son and other Victor executives explained to the company's remaining

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[113]Aldridge, 92-93, 95; R. J. Wakeman and Tim Gracyk, "Brunswick's 'Light-Ray' and Panatrope Era--and Beyond, V78J 13 (Autumn 1998): 3-5, 9-10; for the Victor staff's comfort with horns, see "Recent Developments in the Recording and Reproduction of Sound," undated typescript stencil (c. 1926), 13-17, in Hagley 2069, Historian's series, box 3, folder 21. Brunswick announced the $350 Panatrope in August 1925, but production problems limited the company to demonstrations until the fall of 1926, when Victor began shipping its Electrolas.

[114]Aldridge, 87-88, 93; quote from "Victor Company Plans. . .," Young Papers, box 149, folder 291.

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distributors how Victor would share the losses from fifty percent discounts with its sales branches. Then Fenimore Johnson "spoke the magic words, 'new Victor products,'" explained the company's contracts with AT&T and RCA, and demonstrated what the company's new ad agency, N. W. Ayer, called the "Orthophonic" Victrola.[115]

At the same time, it, Columbia, and Brunswick began releasing electrically recorded discs to dealers and the public without explaining the difference in sound. Although Olga Samaroff made Victor's first such recording in March, the first disc released featured two songs from the University of Pennsylvania's Mask and Wig Club's Joan of Arkansas and went on sale in Philadelphia in April.[116] Like other electrical recordings released for the next eighteen months by the three companies, it displayed nothing to promote the new technology. The labels remained the same except for June, 1926, when the term "Orthophonic" was briefly added. The only indication on the record was a "VE," for "Victor Electric," stamped in the shellac between the tail-out grooves. Not until November 1926, in time for the Christmas shopping season, did Victor roll out a new label,

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[115]Gelatt, 227; Aldridge, 88, 93; E. R. F. Johnson, 114-18, quote on 117.

[116]Sooy, "Memoirs," entry for March 11, 1925; "First Electrically Recorded Record No. 19,626," Hagley 2069, Historical Series I, Box 1, folder 27.

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promotional record sleeves, and a catalog listing the company's electrical recordings.[117]

This gradual approach to aural acculturation made sense for several reasons. Eldridge Johnson had spent the better part of six million dollars on a mostly futile attempt to sell traditional Victrolas. Any advertising that promoted the new system threatened to alienate satisfied customers; at least, it should be deferred until inventory had been sold off and the recording staff had built up an electrically based repertoire of discs. Until then, the companies agreed to downplay the basis for the new recordings each company began to circulate amongst its distributors and dealers.[118]

Just as importantly, Victor was running out of money. The surplus of five million dollars at the year's beginning melted down to $123,000 by year's end. Belford Royal stopped Johnson from spending his own fortune to prevent layoffs, but monthly overhead on the plant--including the retooling and orders from RCA for Radiolas--and the write-offs from discounted inventory left Victor with far less money than it ordinarily budgeted toward a new product.[119]

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[117]"First Electrically Recorded Record No. 19,626," in Hagley 2069, Historian's series, box 1, folder 27.

[118]Gelatt, 225-26.

[119]Victor Talking Machine Company Annual Report for 1925, AHC, courtesy Raymond R. Wile; E. R. F. Johnson, 114.

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In addition, the nature of the innovation almost demanded a word-of-mouth campaign. The reason for consumers to spend $275 on the new Credenza was not so much styling, although the company commissioned Virginia Hamill to turn Johnson's awkward hybrid consoles into veneered furniture that resembled a bureau.[120] The primary point was the Orthophonic sound, and that people had to hear in order to want to buy it.

Therefore, in September the company shipped dealers demonstration models and electrically recorded discs to show off the capabilities of the new technology. Dealers sent out invitations to elite members of their community and to classical musicians and other sound professionals whose word others would accept as authoritative. In October, N. W. Ayer ramped up full-page ads proclaiming "Orthophonic!" in national magazines to announce Victor's "Opening Day" on Saturday, November 2. On that day the company's dealers would debut a "musical instrument which in performance and in construction is unlike, and vastly superior to, anything the world has ever known."[121]

Despite the retention of the traditional Victor font and trademark, the ads marked a revolution in the company's advertising. The only precedent

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[120]Baumbach, 194, and compare illustrations of the Orthophonic line with earlier models, passim; Aldridge, 89. Victor raised the price of the Credenza to $300 in January 1926.

[121]Aldridge, 88; quote from ad reproduced in Weber, 119.

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was Johnson's enclosed horn Victor-Victrolas in the years between 1906 and 1910 when, despite a claim to "the richest, sweetest, most mellow tone ever heard," the attraction of the product lay in its appearance, the enclosure of the talking machine in a furniture cabinet.[122] The illustration made the change self-evident. In 1925, the novelty was in the sound. An exclamation point after "Orthophonic" and the repetition of the word "new" helped persuade potential consumers agree that "Hearing is necessary because description is inadequate."[123]

The ads could not be too specific about the source of change. At this stage in the electrification of the American home, few people understood the power system pervading their lives. Far fewer realized or responded to the implications of electrical theory for quantifying qualities of sound that had been described vaguely as "tone" for a generation. Nor would it do to tell a customer buying the Credenza that the sound improvements arose from research to improve the telephone, or a buyer of the $1000 Borgia II a year later that electrical reproduction came courtesy of GE. Instead one ad mentioned how Victor, "in cooperation with the world's greatest authorities

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[122]Ads reproduced in Weber, 103-105; Baumbach, 45, claims that the sound of records played on the enclosed Victrolas was inferior to that from players with exposed horns.

[123]Ad in Weber, 119 and ad for "The new Orthophonic Victrola," c. October 1925. Victor advertising did not begin to use exclamation points until the competition within the industry and with radio developed in the 1920s: ads in Weber, passim.

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on sound and acoustical principles," made practical the application of "matched impedance . . . this scientific truth to the reproduction of musical sounds." The important point in marketing, then, was an emphasis on how the "scientifically designed amplifying system" affected "the whole range of performance" and gave it a "roundness and a resonance wholly new."[124] Notably absent in the promotion was the contribution of the new records to the sound generated by the high-priced Victrolas.

The campaign and strategy worked: Bell Labs and Victor were not making up the change in sound. Edison's private detective reported on the combination of Orthophonic Victrola and electric recordings in early October. The "instrument" gave "the best reproduction of tone I ever heard." Listeners at a demonstration at the John Wanamaker department store in Philadelphia agreed that it represented "an improvement on the Edison Tone. . . . More volume without distortion."[125] Within a week of Victor Day, orders for the four Orthophonic models poured into the

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[124]Quotes from ad in Weber, 119, and "The new Orthophonic Victrola."

[125]"In re—Victor Talking Machine Companys New Orthophonic Victrola," handwritten memo by [Joseph] McCoy, October 9, 1925, Edison National Historic Site, courtesy Raymond R. Wile. Visitors to the Eldridge Johnson Victrola Museum in Dover, Delaware, can hear for themselves the differences when a docent plays acoustically and electrically recorded performances on a Victrola XI, manufactured between 1912 and 1921, and an 8-30 Credenza Orthophonic Victrola, one of the four models Victor debuted in 1925.

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Camden headquarters as Victor's stock nearly doubled the year's low price.[126]

Dealers followed up with demonstrations of electrical recording and Orthophonic reproduction to community organizations ranging from fraternal orders to sewing circles and religious groups.[127] They demonstrated the new Victrolas using records categorized to appeal to audiences preferring popular music, popular without jazz, or "the higher types of music." Marches by Arthur Pryor's band made all three lists, Leopold Stokowski and the Philadelphia Symphony's rendition of the "Danse Macabre" fit the first, while Fritz Kreisler conducted "Indian Love Call" for the second group and "Trasquita Serenade" for the third. Sales for these records rose accordingly.[128]

In response, management committed to production of eight more models before Christmas and twenty-nine others over the next four years. Those featuring the Orthophonic horn, electrical playback, or a

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[126]Aldridge, 93; Gelatt, 227.

[127]Aldridge, 88-89, 95.

[128]"For Orthophonic and Electrola Demonstrations," Hagley 2069, Historian's series IV, box 6, file 41: "Orthophonic Victrolas--Miscellaneous;" see also the list of nine recordings in Aldridge, 89. Victor later promoted a six-disc album of Orthophonic records of "widely different music . . . from the concert orchestra . . . down to the half spoken patter of the rough-and-ready comedian." See insert after p. 40 of V78J 8 (Spring 1996).

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superheterodyne radio retailed in price from $85 to $1,750. The number of models was not solely a case of classifying customers economically. The late 1920s marked a period of hybrids in home sound reproduction. Besides continuing to offer portable players with the standard enclosed horn, Victor made and sold Victrolas with Orthophonic reproduction, "Electrolas" with electromagnetic pickups amplified through the Orthophonic horn or an electromagnetic speaker cone, and radio-phonograph combinations where the radio sound could be amplified through speaker cone or acoustic horn. In addition, in 1927 Ben Carson designed Victor's first record changer, enabling those who could afford the $600 machine to play twelve records consecutively. Some of these were powered by the traditional springwound motors while others offered electric motors for alternating, direct, or both types of current.[129]

Between the national trend toward home electrification and the continuing research and development of electrical reproduction for the sake of radio reception and motion pictures, however, the future path of the phonograph was becoming apparent.[130] Even Victor's management

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[129]Aldridge, 95-97; E. R. F. Johnson, 118; for prices, release dates, and specifications, see Baumbach, 163-226, passim, and 211 for the 10-50 Automatic Orthophonic.

[130]For the work at General Electric on electrical reproduction in the mid-1920s, see Edward W. Kellogg, "Design of Non-Distorting Power Amplifiers," and discussion, AIEET 44 (1925), 302-15; Chester W. Rice and Kellogg, "A New Type of Hornless Loud Speaker," AIEET 44 (1925), 461;

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responded after Eldridge Johnson sold his majority share in the company to two Wall Street banks.[131] In 1928, the company hired Frank Massa and his M.S. in electrical engineering fresh out of the Massachusetts Institute of Technology. At the Camden plant he found that tube amplifiers remained "scientific curiousities." Despite advances in microphone technology, the main studio remained on the eighth floor so that the Sooys could drive the recording turntables by falling weighted cords. Massa joined Haigis and Hewitt in building their own equipment for testing new playback systems. Until these could be perfected, the engineers analyzed the components through circuit analogies. Early in 1929 Massa built a beat frequency oscillator, drawing on information from RCA's researchers and using a garden hose, to measure sound pressure and loudspeaker transduction of given inputs as a function of frequency.[132]

Kellogg, "Electrical Reproduction from Phonograph Records," AIEET 46 (June 1927), 903-12; and Kellogg, "History of Sound Motion Pictures" (Society of Motion Picture and Television Engineers: June, July, and August 1955), 9-10, reprinted from Journal of the Society of Motion Picture and Television Engineers 64 (June, July, and August 1955).

[131]Gelatt dates the transaction with Speyer & Co. and J. & W. Seligman a year early, 245-46; Aldridge, 99, and E. R. F. Johnson, 118-19, have more details.

[132]"Frank Massa--A Pioneer in Electroacoustics," UnderSea Technology (February 1972), 20-21; Frank Massa, "Some Personal Recollections of Early Experiences on the New Frontier of Electroacoustics During the Late 1920s and Early 1930s," JASA 77, no. 4 (April 1985): 1296. Massa exaggerated the conditions at Victor. For evidence of earlier electronic measurement equipment, see "Recent Developments in the

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The variety of alternatives, combined with the acoustically and electrically recorded discs, the lingering Edison Diamond Discs and cylinders, the improvements to radio broadcasting and reception, the development of electric public address systems, and the advent of sound motion picture gave people a broad palette of sound reproduction possibilities.[133] At the top end, radio buffs added record reproduction to their efforts to improve reception of broadcast programming. Like male devotees of cars and computers, radio buffs developed opportunities to master the system they bought into, and to improve its characteristics along qualities they valued by mixing components from different companies. The late 1920s saw them begin to switch from long-distance reception as a goal to volume and better sound. The ads and articles of their magazines document an expansion in interest from amplifying power and loudspeakers in 1926 to phonograph motors and pickups and tuning circuits in 1928. In selling its pickup, the Pacent Electric Company touted the "thrills--the enjoyment--of hearing your favorite records the new way--ELECTRICALLY--with a superb cathedral-like tone-quality of

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Recording and Reproduction of Sound," (n. 108 above), 7-9.

[133]Edison continued to manufacture various models of the Amberola cylinder phonograph until he left the record business in October 1929. In 1926, he introduced a longplaying record; in 1927, the improved acoustic "Edisonic" disc phonograph; and in the summer of 1929, a lateral-cut electrically recorded disc. See Gelatt, 248-50; Marco, s.v. "Edison Diamond Disc," "Edison Record Players."

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reproduction."[134] This period also saw the beginnings of the transition from "tone" and "perfection" of sound reproduction to "fidelity" in power transformers and loudspeakers. Jensen's Dynamic Speaker guaranteed the "utmost fidelity" while Browning-Drake felt "privileged" that its speaker offered "the nearest approach to fidelity in musical reproduction yet."[135] Their customers were a small group seeking better sound from either their records or the radio stations only just beginning to come under government regulation. But their devotion to the possibilities of reproduction and to the component manufacturers working on the periphery of the industry would ultimately contribute to the development of a mass market for "high fidelity" a generation later.

The rest of the middle class enjoyed some of the aural benefits of electrical reproduction in the increasingly popular consoles. Even after the phonograph companies stopped making acoustic reproducers, however, large portions of the population continued to listen to records on older and portable wind-up players. One result was that those people never heard the full capability of the newer records. Race and class help explain the difference in what people heard, but the overriding explanation for the

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[134]Quote from Pacent ad in Popular Radio, April 1928, 331. This paragraph also draws on Radio News, November 1926, and Radio, June 1928, all at the LAB.

[135]Quotes from Jensen ad, Radio, June 1928, 33, and Browning-Drake ad in Popular Radio, April 1928, 333.

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disinterest in full-frequency reproduction is that most listeners cared about music.[136]

Section VII: Listening to the New Sound of Music, 1925-1929

For another group of record buyers, electrical recording made a difference, but not in ways one might expect. Up to this point, the role of the customer has been limited to inferences from sales figures. In the 1920s, however, a small group of "music lovers," fans of music in the classical tradition, organized the first independent magazine dedicated to the consumption of recorded sound. Along with other evidence, the evaluations and discussions within the pages of the Phonograph Monthly Review suggest that classical music enthusiasts appreciated the improved quality of recordings and revelled in the increased repertoire available, but only to a point. The new science and engineering that accounted for quantifiable differences in sound brought with it a new language to define the parameters. This had nothing in common with the traditional terms of aesthetic description used to evaluate the sound of a musical performance. Reviewers commented on records in the language of musical criticism whether they listened to acoustic or electric recordings. In ways rarely made

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[136]Women dominated purchasing decisions for phonographs and bought the majority of records; producers designed the portables to look like luggage cases. See William Howland Kenney, Recorded Music in American Life: The Phonograph and Popular Memory, 1890-1945 (New York: 1999), chapter 5, especially 90-91, 104; and Aldridge, Appendix IV, 109, showing that by 1928 "Hand W[ound?]. Luggage" constituted nearly half of Victor's player sales.

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explicit, but always connoted, they distinguished between the effect of performance and recording quality on the listener's appreciation. They rarely assigned specific responsibility for the recording to the engineer, the acoustics of the location, the disc material, or the phonograph on which it was played. In a choice between two versions, different critics argued for the pre-eminence of artistry or sound quality. As companies hastened to record the same compositions with different symphonies and conductors, the embarassment of riches added to frustration on the reviewers' part because of their inability to keep up with the output, and on that of the prospective buyer, who could not afford the variety and wanted guidance in making selections.

The sound had improved, and would continue to do so as engineers refined their understanding of the materials, processes, and phenomena with which they dealt. But electrification, and the new technical definition of sound reproduction, opened a divide in the 1920s in the culture of recorded music between what C. P. Snow later termed the "two cultures" of science and the arts. The music lovers, focusing on content, never developed a vocabulary to mark the improvement in the form of delivery. For them the sound of recordings either never improved or they did not care.

Electrification had less of an effect on repertoire, consumer organization, or standardization than it would appear. That Columbia

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debuted its "Musical Masterworks Series" in the United States in the mid-1920s and was followed by Brunswick and Victor in offering concert recordings had more to do with business strategy than with the versatility of electrical recording. That the first American magazine devoted to phonograph music appeared in September 1926 was another consequence of Columbia's efforts to develop its share of the middle-class market that Victor dominated.[137]

One year after Victor and Columbia debuted their new systems, Bostonians W. H. Tyler, J. F. Brogan, and Axel B. Johnson began publishing in September 1926 the first American magazine "devoted to the best interests, not of the industry alone, but also of the great music-loving and record-buying public." In this approach, the editors of The Phonograph Monthly Review hoped to "serve as the intermediary between those interested in recorded music as amateurs and those as professionals. It will give a voice to the wishes . . . of the former and pass the best of these on to the latter." Records and phonographs would "be carefully and impartially studied and reviewed" by the Review's "staff of experts."

Despite the claims of objectivity, the content of the first issues suggests that the magazine served as a stalking horse for Columbia to reduce Victor's industrial dominance. Louis Sterling, owner of Columbia

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[137]The copy of the first issue at the Library of Congress is datestamped September 18, 1926: The Phonograph Monthly Review (hereafter PMR), October 1926, 1.

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Graphophone Company, Ltd., had purchased its American counterpart in March 1925 to gain access to the Bell licenses. He had overseen the development in England of unabridged classical and theatrical recordings as a means of overtaking the prestige of the Red Seal vocalists since 1909.[138] Far more energetically than the Victor interests, Columbia and European phonograph companies recorded symphonic music long before electrical recording made it more convenient and the reproduced sound more true to life. One result in England was the independent growth of record societies and clubs and the publication of magazines devoted to what could be called "phonoculture." Based on the English experience, Sterling intended to exploit the classical tradition on disc to build up American Columbia's reputation with the middle-class consumers who thought Caruso arias represented high culture.

As in England, where writer Compton Mackenzie started The Gramophone in 1923 to advocate the recording of "good music," Columbia supported the organization of the Review.[139] Based on his experience, the

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[138]For a review of classical recording developments in England, see Gelatt, 177-81, 225-26.

[139]Quoted in Gelatt, 202. The development of the phonograph and gramophone in Great Britain deserves separate study, based on the Britons' retention of separate terms for cylinder and disc players. Mackenzie's biographer devotes little attention to his interest in recordings. See Gramophone: The first 75 years (London: 1998); Mackenzie's biography and autobiographical excerpts at www.gramophone.co.uk/CMbiog.html, visited January 11, 1999, and his first article on the gramophone from the "Music of

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company's New England branch manager wrote an article on how to organize phonograph societies, where devotees shared their interests and records. Columbia's recording director explained "The Columbia Library of Masterworks," the company's ongoing series of releases of symphonies, concertos, and quartets. Columbia's president and the New England managers received profiles and photographs, while the local Brunswick manager also contributed pieces explaining the differences between electrical and acoustic recording and the "Panatrope . . . the world's first purely electrical reproducing instrument." By contrast, only the reminiscences of its Foreign Department's musical director represented Victor, and he had nothing to say about the company's current products.[140] Despite Axel Johnson's claims of receipt of Victor records for review, none of them appeared in the first or second issues. Meanwhile, after a review of Columbia's recording of Berlioz's Symphonie Fantastique, Johnson urged the company to "keep up the good work, the reward will be there."[141]

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the Day" column of The Daily Telegraph, September 2, 1922, reproduced at www.gramophone.co.uk/bookextrcpte.html, visited January 11, 1999.

[140]William S. Parks, "Suggestions on the Formation and Maintenance of Phonograph Societies," 32; George C. Jell, "The Columbia Library of Masterworks," 11-12; Elmer C. Nelson, "Brunswick Electrical Recording," 26-27; "What is the Panatrope?" 19-21; Nathaniel Shilkret, "My Musical Life," 7-8, all in PMR, October 1926. Jell's profile appeared in PMR, January 1927, 152.

[141]Editor's note, PMR, October 1926, 37.

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Promotion of good music required determining the qualities of the recordings. Label favoritism and aesthetic concerns aside, this was no easy task. Records, while superficially interchangeable, continued to be recorded at anywhere from seventy-four to eighty-two rpm and with different characteristics of emphasis, depending on the types of microphone, amplifiers, and reproducing system used. Recording engineers applied their own techniques and preferences in recording, depending on room acoustics, microphone placement, and the point on the frequency range where they limited the amplitude--and dynamic range--of the soundwaves cut into the wax recording tablets.

Johnson therefore proudly promoted the Review's listening "Studio," where the reviewers could play records on acoustic and electric phonographs donated by Victor, Columbia, Brunswick, and Edison, on which "our technical experts" attached one of twelve soundboxes. Profiles of Columbia staff notwithstanding, Johnson asserted that when it came to records, for the magazine's "policy of strict impartiality, it is only fair that each company has the opportunity of having its records played on its own instrument."[142]

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[142][Axel B. Johnson], "Topics of General Interest," PMR October 1926, 30; quotes from [Johnson], "Analytical Notes and Reviews: General Review," PMR December 1926, 135. For profiles, see "Mr. Frank Dorian, Assistant to the President, Columbian Phonograph Company, Inc.," and "J. J. Doherty, Manager of the Philadephia Branch of The Columbia Phonograph Company," PMR, 125, 130.

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On the other hand, it was hardly fair to consumers who did not have the luxury of multiple phonographs for their record collections. Nor was it fair to the expanding classical catalogues available to devote nearly a page and a half, in double-columns, to a critique of Felix Weingartner and the London Symphony's recording of Beethoven's Ninth Symphony. The reviewer, Moses Smith, spent five days listening to the eight double-sided twelve-inch records: ten times in their entirety, plus various sections, on three different phonographs. He compared it to two European acoustic recordings as well, and concluded that the "Columbia recording is greatly superior to the other two because of the new process of recording." It helped that Smith preferred Weingartner's interpretation, for in the course of his review he pointed out the many ways in which performances on the Polydor and Parlophone discs were superior to the London Symphony's. Nonetheless, the "first requisite in reproducing music is that it shall sound in recorded form as much like the original playing as possible. The new type of recording makes possible a smoothness and roundness that were not attainable by the older method."[143]

Others joined Smith in his praise of the new technology. In a review of a record of the Scherzo and Nocturne of Mendelssohn's Midsummer Night's Dream, Robert D. Darrell found that Brunswick had "contributed

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[143]Quotes from Moses Smith's review of Beethoven's Ninth Symphony, Columbia Masterworks Set no. 39, in "Analytical Notes and Reviews," PMR, October 1926, 35, 34.

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almost as much as the composer." The company extended the playing time of four and a half minutes for a twelve-inch disc by nearly ninety seconds, permitting uncut performances. Arturo Toscanini took advantage of the playing time and Charles Hoxie's pallophotophone to give "a reading surcharged with the spirit of both the music and the play. It is doubtful whether any . . . record has ever exhibited such amazing crescendos. . . . in the Nocturne . . . the final long held high E in the violins will give a thrill to even the most hardened phonograph enthusiast."[144]

For some critics sound quality did not necessarily trump performance. A month later a writer on Victor's early attempt "to record a real symphony orchestra" maintained that the "success is as evident today as it was in 1914 [sic]. All of the startling developments and splendid recordings since that time cannot dim either the relative or absolute brilliance of the records."[145] Nor did the readers and consumers approve of electrification or the attitude that accompanied it. One letter writer complained of the attitude "of even the Victor dealers" toward "'That old mechanical stuff.' Yes, that old mechanical stuff, but records like Tchaikowsky's Fifth Symphony will never

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[144] [Ronald D. Darrell], review of Brunswick 50074, PMR, 37-38; R. J. Wakeman with Tim Gracyk, "Brunswick's 'Light-Ray' and Panatrope Era--and Beyond." V78J 13 (Autumn 1998): 5, 9.

[145] "The Boston Symphony Orchestra--Its History and Recordings," PMR, November 1926, 10.

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be surpassed."[146] Even Smith and Darrell had to agree in that case. "In spite of all the improvements" since Albert Coates led an anonymous orchestra through the piece in 1924, Darrell wrote, "it is hard to comprehend anything ever surpassing this work. Even in the tone coloring there is a beauty and a naturalness that will outlast all the changes in processes of today and tomorrow. The old method at its best . . . has something that will never be obtained by any other method." Smith echoed him: "From just a single listening I jumped to the hasty conclusion that this was probably the finest and clearest recording of orchestral records yet produced. That may be an exaggeration, but unquestionably the excellence is very great."[147]

Similar conflicting evaluations of the importance of wider and flatter frequency response arose in the field of bel canto, Victor's traditional strength. Herman Klein, student, teacher, writer, and critic of singing since he heard Jenny Lind in 1863, started writing for The Gramophone in 1924. In his first column, Klein opined that contemporary recordings constituted "a wonderfully truthful and accurate reflection of the voice and art of the singer." Listening to "some records of a bygone, not to say prehistoric, period" on his new Sonora player "demonstrates clearly enough that the

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[146]D. R. to the editor, PMR, January 1927, 160.

[147][Ronald D. Darrell], review of Tchaikowsky's Symphony No. 5 in E Minor, Victor (Music Arts Library) nos. 55281-6, in "Re-Reviews," and Moses Smith, "Note on Recording of Tchaikowsky's Fifth Symphony," both in PMR, January 1927, 181, 182 respectively.

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improvement in the modern gramophone is due at least as much to the reproducing as to the recording mechanism."[148]

Presumably the balance between recording and reproduction swung back to the former over the next year. Yet he found that 1925 was "a wonderful year for the gramophone . . . not so much for the mechanical developments and improvements in the instrument itself" as for "above all, perhaps, the ever-widening field of its instrumental repertory."[149] Only in 1926 did Klein acknowledge the technical changes at any length. The "latest His Master's Voice gramophone" that he received in April was "a very wonderful machine--the 'last word,' in fact, in every detail that makes for reproductive perfection."[150] In reviewing the records for the year, Klein opined that unspecified advances in recording no longer made the task "the experimental, doubtful, nerve-wracking one that it was a short time ago. . . . I would give it as my opinion that the purely vocal achievement to-day bears evidence of greater spontaneity and ease, of less trepidation and strain,

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[148]William R. Moran, ed., Herman Klein and The Gramophone (Portland, Oreg.: 1990), 1-2; quotes from "The Gramophone and the Singer," reprinted from The Gramophone, June 1924, in Moran, 65.

[149]"Some Operatic Records of 1925," The Gramophone, January 1926, reprinted in ibid., 128.

[150]"Covent Garden Opera and Gens from Half-forgotten Operas-III," The Gramophone, May 1926, reprinted in ibid., 146.

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and even of a stronger dramatic atmosphere, than it has done heretofore."[151]

Klein did not pursue this opinion in his columns. He continued to focus on the performances of the vocalists irrespective of the means by which they were recorded or reproduced. He praised a Polydor disc of duets from Don Giovanni and Le Nozze di Figaro although it was not "a specimen of the wonderful new electrical recording." A recording of Mefistofele at Covent Garden had the benefit of conveying "the very elements of a rendering upon the stage itself." Klein emphasized the "historical value;" the duets, however, were also valuable because "method was, sui generis, of the best; and the two voices were as delicately balanced as the style of the singers was pure Mozartian."[152] For music lovers, then, whether they were one of the thousands buying full symphonies or the millions buying jazz singles, the shift to quantitatively better sound mattered less than the performances they could obtain. If records made in 1929 sounded better than records made in 1922, most people did not care.

Section VIII: The Future of the Record

What effect did the new technologies of sound recording and reproduction have on the record itself? Beyond new labels promoting the

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[151]"The Years's Best Operatic Records," The Gramophone, December 1926, reprinted in ibid., 167.

[152]Ibid., 167, 168.

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change in sound, none were apparent. Yet the increased frequency range of recording and increased sensitivity of the electrical pickups meant that listeners would hear more of the high-frequency noise from the needle abrading under pressure and contact with the mineral particle filler in the record grooves.

Engineers tried to resolve this in two ways. Julius Weinberger at RCA's Technical and Test Department developed a scratch control circuit tuned for cutoff at 4500 cps, although it had "a decided effect at 3500 cycles." This had "the cost of some articulation in speech but on the whole gives a more pleasing result, particularly with musical numbers."[153] Victor refined the diameter of the limestone and shale particles to raise some of the noise frequencies beyond detection, claiming the use of "a material eliminating the unpleasant scratch."[154]

Columbia approached the problem similarly while reviving Marconi's laminated disc. Louis Sterling had employee William Forse assign his patent for an improved record to American Columbia late in 1924, which led to the manufacture of laminated records with mineral grains ground to a fineness beyond the sensitivity of the stylus. The system was

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[153]Edward W. Kellogg, "Electrical Reproduction from Phonograph Records," TAIEE 46 (June 1927): 910, f.n. 7 for Weinberger's circuit.

[154]Quote from Victor ad brochure, "Orthophonic Recording" (n. d.), 5, reprinted in centerfold of V78J 8 (Spring 1996).

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apparently more effective than Victor's. Without the protrusion of grains in the grooves, or divots left by grains that worked loose, Columbia's shellac records enjoyed a reputation for no "needle scratch" well into the 1940s.[155] This increased dynamic range had its own drawbacks, however. As Smith put it in the Beethoven review, "the Columbia records cannot disguise some pretty poor playing on the part of the upper strings, which would have been disguised by the old style of recording."[156]

In 1929, with consumers of every musical taste happy with the sound of the music they heard from their players, no one found it worthwhile to change the phonograph record. Made of natural ingredients, it remained a pre-modern artifact in an otherwise updated form of entertainment. Victor, under the stewardship of the Wall Street bankers, was in no position to innovate another radical innovation, and with profit levels resuming their pre-radio levels, felt no need to do so.

With RCA's purchase of Victor in 1929, however, David Sarnoff's earlier calls for a "combination instrument" took on new meaning. For years he had pushed his superiors to let RCA exploit its radio patent pool. By the late 1920s, with the company under attack as a "radio trust," he

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[155]U. S. Patent no. 1,702,564; Moses Smith, review of "Columbia—Beethoven's Ninth Symphony," PMR, October 1926, 35; Warren Rex Isom, "Record Materials Part II: Evolution of the Disc Talking Machine," JAES 25, no. 10/11 (October/November 1977): 721-22.

[156]Smith, review of "Columbia," 35.

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believed that survival depended on continued innovation that justified the trust. He called on RCA's directors and inventors to pursue all branches of electronic communication--radio, television, film, and phonography--because a "technical advance in any of these fields might benefit all the other[s]."[157] No one could predict a consumer's preference for one form of entertainment over another. In industry, "the supplantive competition which modern science may breed in the laboratory" meant not just having researchers develop "the better mousetrap" but having "those who have . . . found a means that would make mousetraps unnecessary."[158]

For the phonograph and record, this meant not simply improving the existing system, but renovating it completely. Victor's staff was now integrated with engineers culled from General Electric, Westinghouse, and RCA who specialized in electrical sound. Among their other assignments, the RCA Victor staff would develop home reproduction that offered more sound and less noise using record materials cheap enough for the mass market. Whether the public desired it was less important than making it

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[157]"Address by Mr. David Sarnoff" to the RCA Victor National Distributor Convention, May 19, 1937, Drake Hotel, Chicago, p. 8, in Hagley 2069, Historian's series, box 2, folder 36, "Speeches, 1937-1957."

[158]David Sarnoff, address for the University Club, Boston, MA, January 28, 1928, reprinted in edited form in Looking Ahead: The Papers of David Sarnoff (New York: 1968), 205.

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available. Why it took RCA twenty years to innovate a better record is the subject of the next two chapters.

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Chapter 5: The Strange Career of High Fidelity, 1929-1939

Section I: Introduction

The onset of the Depression cut short the prospect of resolving the presumptive anomaly raised by the noisy material from which record were made. The lack of consumer response to most innovations during the 1930s forced entrepreneurs to reconstruct the mass market for records, with minimal assistance from inventors. We cannot, however, assign all the responsibility for the lack of change in the record and its sound to the failures of the capitalist system. Inventors, entrepreneurs, and consumers continued to fulfill their roles and negotiate their place in the evolution of the record, albeit under constricted conditions.

Insulated by university tenure or the subsidized laboratories of the chemical and telephone industries, scientists and engineers continued to research new materials and the physical relationships within the components of the phonograph system. Through professional journals and meetings, they stayed in touch with the corporate engineers more focused on product innovation. Collectively, they defined the technical notion of "high fidelity" for the recording and reproduction of sound.

Seeking to maintain the operation of capital equipment and the employment of thousands of workers, corporate executives and managers continued to try to persuade consumers of the value in a

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variety of innovations, ranging from ten-cent records to thousand-dollar phonographs. Constrained by reduced budgets, consumers rich and poor continued to evaluate the utility of these products in light of their various needs, wants, and desires.

To be sure, the shrinkage of the economy contributed to the divergence of participants' decisions. No one could ignore the evaporation of ninety percent of the market in the space of three years. Nonetheless, the state of the technology, the management of innovation, and conditioning of the consumers' ears all frustrated attempts to revive the market.

While the Depression drove the management of the Radio Corporation of America (RCA) to introduce products before inventors had solved the problems that affected their performance, it became clear that the company's inventors did not yet understand all of the technical requirements for "higher fidelity" as marketed in 1936-37. The problems of disc sound reproduction enjoyed the attention of an array of electrical engineers who also worked on sound technologies for film and radio. Ironically, provisions for their solution languished from the lack of a budget. A product that contributed less than four percent of RCA's

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revenues in mid-decade received far less priority for research than other, purely electronic technologies.[1]

In addition, David Sarnoff's acquisition of the Victor Talking Machine Company by RCA in October 1929 and the transfer of engineers from RCA's parent companies in 1930 resulted in internecine conflicts and chaotic efforts to construct a corporation that fit the company's new role as a manufacturer. Entrepreneurial indecision over which market to pursue--the low or high ends, or the disapppearing middle class--resulted in attempts to cater to all of them. The shuffle of managers through the company and the shrinking budget for support of new products prevented any continuity of corporate support.

Despite the lack of success in radical innovation, participants in the evolution of the record learned a great deal about records and sound reproduction. Researchers at Bell Labs and Harvard University demonstrated records and technologies approaching the high fidelity ideal. Their research on the nature of sound, the qualities of its

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[1]RCA Victor Records' 3.4% share of RCA's income is based on its 7.4% share of RCA Manufacturing's sales in 1936; see the bar chart in the Scanner 2, no. 3 (April 1937), 4. RCAM's net sales for 1936, prorated from the first ten months of the year, were $46,205,000; see "RCA Mfg. Co., Inc. And Subsidiaries Consolidated Statement of Income for Month and Ten Months Ended October 31, 1937," in NBC Papers, Central Files: Correspondence, box 56C, folder 36: RCA (1937), State Historical Society, Madison, Wisconsin. RCA's revenues for 1937 were $101,200,000; see Robert Sobel, RCA (New York: 1986), 107.

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reproduction, and the relationship between stylus and groove became the technical basis for high fidelity reproduction after World War II.

RCA Victor engineers gained experience working with new plastics including Vinylite, that eliminated much of the traditional needle scratch, even though no one was willing to subsidize its supply until consumer reduced production costs to a point competitive with traditional shellac blends. Some engineers extended the frequency range of records through process improvements in recording and manufacturing. A third group learned a great deal about the challenges of transducing cleanly the mechanical energy generated by soundwaves into electrical energy and back again, a process necessary for undistorted recording and reproduction from the record. These experiences also contributed to RCA's approach to sound reproduction in the late 1940s.

Managers at RCA Victor concluded that radical innovations aimed at the high-end market and based on better sound reproduction did not merit the investment. They would base future initiatives on the anticipation of mass market demand that would occupy the company's expanded production capacity. At the same time, entrepreneurs in the record department realized the value of classical music as a means of resisting the price competition in popular records. One of these men would take that lesson to Columbia Records, while those focusing on the

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broader market would find their approach aligned with that of new management at RCA during the war.

Music lovers in turn gained in influence and experience in three ways. Their purchases of the more expensive classical record albums during the Depression helped keep the industry afloat, and sustained the specialist magazines they organized around their interests. By the later 1930s, the growing interest by radio listeners in symphonic music and revival in the record industry pointed the way for music lovers to become leaders of a new audience for classical records. Finally, while they suffered the same problems as other consumers with record changers, their interest in longer musical compositions meant they would always be more open to the revival of a longplaying format as an alternative solution.

On the other hand, the music lovers probably lost influence with some corporate entrepreneurs. The fact that, by the middle of the decade, these consumers no longer compared electrical recordings to those of the acoustic era suggests that they recognized the improved sound of records, but not to the level of profit desired by RCA Victor's managers. Along with other consumers, music lovers showed little interest in more expensive phonographs on which to play their records. Was the rejection one of economics, conditioning to the poor quality of most

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reproduced sound in the 1930s, or a problem of distortion not yet calculated by the researchers yet perceptible to the listeners?

No one could answer with any certainty, but at the end of the decade, with industry sales approaching new records, one RCA Victor engineer investigated the subject of listener preferences. He confirmed that most people preferred remarkably low frequency ranges in reproduction; Victor's marketers and engineers responded accordingly in the next year's product line. At the same time, the observation that consumers were increasingly interested in better record changers dovetailed with the frustrations of RCA Victor's resident expert in the technology. The story of how the company and its consumers resolved the presumptive anomaly of musical continuity on 78s is part of the final chapter.

Section II: The Depression, 1929-1933

> "Until the time when all these people who do not know their own business and take a positive pride in not knowing it are set to work digging ditches and scrubbing floors, recorded music can never make any great advance in this country."[2]

In the fall of 1929, Emile Berliner's disc record system fell into the control of the man and corporation best equipped to improve and sell it. Over the last half of the 1920s, RCA vice president David Sarnoff

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[2]Theodore R. K. Schwartz to the editor, Phonograph Monthly Review (hereafter PMR), January 1927, 159.

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persuaded his board of directors to buy Victor Talking Machine Company and organize RCA to develop, manufacture, and market radios, phonographs and records, and other media based on electronics. The acquisition was one part of a strategy that made RCA a holding company not only for patents but for companies using those patents. Sarnoff had already formed the National Broadcasting Company (NBC) to provide content for radio owners; Radio-Keith-Orpheum (RKO) to promote sound-on-film technology in movie theatres; and in 1929-30 he acquired a number of music publishers to add to the value of the music which would circulate through all these companies.[3]

Despite the emphasis this arrangement appeared to put on content, Sarnoff was devoted to the technology that made RCA and his career possible. Frustrated by his own inability to complete an electrical engineering degree and impressed by those who made his visions for communications possible, he turned RCA into a company of engineers, one that emphasized technological innovation over marketing. During his tenure as president from 1930 to 1949, RCA never led in radio sales despite its patent pool and production facilities. Instead, Sarnoff underwrote research and development for better electronic media

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[3]Russell Sanjek, American Popular Music and its Business: The First Four Hundred Years, vol. III from 1900 to 1984 (New York: 1988), 111.

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systems. Overriding the protests of RCA Victor's presidents, he gave his engineers funding to find ways to reduce the noise and improve the clarity of transmission and reception of signals in radios, television, and phonographs.[4] Despite the reservations of others in his hierarchy about the utility of the latter technology, Sarnoff included phonographs and records in the electronic future.

Within three weeks of the board's approval of the Victor purchase, however, the stock market crashed, and with it went the record business. More expensive as entertainment than radio or movies, the phonograph became the subject of desperate attempts to make it more appealing to the very wealthy or the newly poor. The popular music business began to slump early in 1930, and record sales declined thirty-nine percent from the year before. They plunged another sixty-one percent, to $18 million, in 1931, and nearly halved again in 1932 before bottoming out at $6

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[4]The "Victor" name was retained in various incarnations as a subdivision of RCA during this period. After the first purchase of Victor Talking Machine Company in March 1929, it was renamed the Audio-Vision Appliance Company until the deal was renegotiated in the fall. For about a year it became the Victor Division of the Radio-Victor Company, making and selling radios and phonograph combinations in competition with RCA's Radiola Division. Toward the end of 1930 Sarnoff ordered the reorganization into the RCA Victor Company. This lasted until 1935, when it was turned into the RCA Manufacturing Company operating the RCA Victor Division. In 1943, RCAM was dissolved, leaving RCA Victor Division and its three operating divisions, Home Instruments, Records, and Engineering Products. Where it appears convenient, Victor will be used as shorthand.

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million in 1933.[5] The sale of the average hit record dropped from fifty to five thousand copies, the royalties from which barely paid the publisher's costs of arrangement.[6]

As sales slid, the larger companies merged. Brunswick Balke Collender sold its Radio-Panatrope-Record Division to Warner Brothers Pictures in the spring of 1930 despite a peak sales year of twelve million discs the year before. A year later the Warners tried to sell the company to RCA.[7] Quixotically its record division doubled the price of its Purple and Gold label records after two years of discounting.[8] In January 1932,

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[5]Sanjek, 112; Steven Traiman, "The Record Industry in the United States," Journal of the Audio Engineering Society (hereafter JAES) 25, no. 10/11 (October/November 1977): 786. Even these figures seem high compared to those documented from within RCA Victor, which by 1932 had minimal competition from Columbia or Brunswick; see n. 9 below.

[6]Sanjek, 122.

[7]"Brunswick Purchase by Warner Bros. Important to Industry," Talking Machine World & Radio Music-Merchant (hereafter TMWRMM), May 1930, 113, 118; Paul Ellison to Owen D. Young, May 28, 1931, Owen D. Young Papers, Owen D. Young Library, St. Lawrence University, Canton, N.Y. (hereafter Young Papers), box 93, folder 223W.

[8]"Increase Prices of Brunswick Records," TMWRMM, April 1930, 52. In February 1931 Brunswick dropped the price on Gold label discs and introduced twenty-five cent "Melotone" records: "Brunswick Melotone Discs Stimulate Sales," Radio-Music Merchant (hereafter RMM), February 1931, 80.

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Grigsby-Grunow, makers of the popular Majestic radio, bought RCA Victor's oldest rival, Columbia.[9]

RCA's record sales matched the industry's collapse. From sales of 34.4 million discs in 1929, the Victor label's total was cut in half for each of the next three years. In 1932, customers bought 3,119,000 records; the ninety percent decline was nearly matched by the seventy-five percent plunge in the company's radio and phonograph sales.[10] One survey indicated that Americans had only 500,000 record players available for use, and most of these were part of a combination with a radio.[11] In 1934,

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[9]"Grigsby-Grunow and Columbia Merger Benefit to Both Firms," RMM January 1932, 44. Grigsby-Grunow made its reputation with the Majestic console radio and led the industry in 1929. See "Mr. Grigsby Mr. Grunow," Fortune, April 1930, 109, 138-40; and "1,250,000 Out of 4,200,000 U. S. Radios," Fortune, February 1935, 76.

[10]Record sales totals from "Fifty Year Story" correspondence, B. L. Aldridge to T. J. Bernard, November 20, 1956, Hagley 2069, Historian's series VI, box 2, folder 63; see also David Giovannoni, "The Phonograph as a Mass Entertainment Medium: Its Development, Adaptation, and Pervasiveness, 1977-1932," (M. A. thesis, University of Wisconsin-Madison, 1980), table 15, 201. For radio and phonograph sales, as well as slightly higher record sales totals, see "Comparison: Records vs. Instruments, units, Victor/RCA/RCA-Victor, 1900-1944," Hagley 2069, Historian's series VI, box 9, folder 46.

[11]Sanjek, 122. The survey may have referred to electrical phonographs, of which Victor Talking Machine and RCA had shipped 282,000 between 1926 and 1931, compared to 835,000 Orthophonic machines in the same period: "Comparison Orthophonic vs. Electrola Shipments," Hagley 2069, Historian's series III, box 5, folder 14, "Miscellaneous."

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coming out of two years in which Victor had shipped a total of 4,500 portable Victrolas, it sold 5,500 phonographs and recordplaying attachments.[12]

Section II: RCA Victor Responds to The Depression

How did the company respond to the Depression? In the first place it followed the same measures other labels pursued. In June 1931 the label ordered all recording sessions limited to single "takes" on the wax recording blanks, and it started paying performers by sessions rather than through contracts or royalties.[13] The board of directors refused to renew the versatile Fritz Kreisler's contract without "greatly modified terms." During the previous five years, the company had lost $425,000 on royalty guarantees.[14]

The division also underwrote promotions other companies could not afford to match. In May 1930 Victor announced the second record

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[12]"Portable (Luggage Type) Victrola Shipments, 1921-1929 [1942]" December 1, 1945, Hagley 2069, Historian's series VI, Box 9, folder 45; "A Review of RCA Manufacturing Company's Radio Receiver and Phonograph Activities Yearly from 1933 to 1940, inclusive, in Comparison with Sales by All Licensees," April 2, 1941, p. 3, Hagley 2069, Historian's series VI, box 9, folder 49.

[13]Sanjek, 117.

[14]RCA Victor Board meeting minutes, April 3, 1930, p. 5, Owen D. Young Papers, box 179, folder 321A, Owen D. Young Library, St. Lawrence University, Canton, New York (hereafter Young Papers).

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exchange in its history, taking customers' old records at 7 1/2 cents credit per disc. It also offered a $76 credit on old Victrolas in the hope that customers would trade up to one of the new Electrolas. This move backfired. Customers applied the credits toward new radios, thereby shrinking the number of players available for discs.[15]

At the same time, in an effort to swell the number of consumers, William Porter, Victor's manager of record sales, initiated the industry's first "Record-of-the-Month Club." Based on the Book-of-the-Month Club and tested with a "selected list of music lovers," the club offered advance notice of the company's releases every month. Members received illustrated flyers lithographed on glossy stock highlighting "Great," "Popular," and "Concert" recordings. After six months of purchases, they received a twelve-pocket album as a reward and an incentive. Two-dollar classical recordings appeared on the front and over time squeezed space for the cheaper popular discs even as they became more esoteric.

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[15]"$76 Trade-in on Old Victrolas," TMWRMM, May 1930, 22-3; "Announce Second Victor Record Exchange," TMWRMM, 24. For the national trend of trade-ins, see "This, That and--Some Random Thoughts Occasioned by Trends in the Trade," TMWRMM, June 1930, 28, col. 3. See also the photograph, c. 1930, of a phonograph graveyard in Timothy C. Fabrizio, "Ordinary People: The Talking Machine in Real Life," ARSC Journal 30, no. 1 (Spring 1999), 22, fig. 1.

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By late 1931, shortly before the program dissolved, Victor promoted Sibelius's Swan of Tuonela on three stapled, stencilled pages.[16]

Finally, Victor management pressed Victor engineers to remove or add value to the phonograph. Approaches included better sound, new record materials, new features, and longer playing time. Marketers tried to persuade the company's dealers to embrace the changes and better profit margins, and reinforce the dealers' interaction with prospective consumers through advertising campaigns.

RCA was big enough to cater to the high and low ends. In both cases, phonograph systems matched the best and worst sound radio had to offer. Radio manufacturers, lacking software to sell, had striven each season to offer improved selectivity, range, or sound quality with the result that radios had improved markedly since 1922. On the other hand, with the saturation of the middle-class parlor market and onset of the Depression, manufacturers began developing smaller, cheaper sets for bedrooms, kitchens, and households unable to afford consoles. As with the phonograph, while leading edge of the technology had improved, it was difficult to assert that the quality of the system overall had made a

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[16]Quote from "Victor Record of the Month Club Formed," TMWRMM, April 1930, 64; Hagley 2069, Historian's series VI, box 3, folder 23: "Record of the Month Club 1930-1931."

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gain, or that consumers who decided with their pocketbooks cared about sound the same way the inventors did.

A. Cheaper Records

One factor contributing to the decline of profits was the development of cheaper records. Before the Depression, a British company, World Echo Ltd., exported postcards and cardboard discs with a recording pressed in resorcinol resin in the summer of 1929. Later that year a New York company sold eight-inch "Broadway" records which suffered from the same problems of surface noise and poor wear.[17]

With the decline in sales and the innovation of cheaper manmade plastics, companies and entrepreneurs began offering records at huge discounts from the seventy-five cents charged by Victor, Brunswick, and Columbia in the 1920s. Three chemistry professors at Columbia University developed a phenolic thermosetting resin they called "Durium." It remained flexible at room temperature. Sprayed onto cardboard, run through a drying room, and embossed by record dies, the discs debuted in Hartford, Connecticut, in January 1930. As the "Hit of the Week," they sold at newstands and chain stores for fifteen cents,

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[17]F. C. Barton, "Synthetic Resin Surface Phonograph Records of Single Face," RCA Victor Company Engineering Department Technical Report (hereafter TR) 112, April 28, 1931, pp. 5-7, Hagley 2069, series XXI, box 115. The boxes of TRs and Engineering Memoranda (EM) had not yet been divided into series when I examined them

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touted by promoters for their light weight, resistance to hammering, and retention of "perfect tones" after two hundred playings. By the early 1931, however, the Durium Product Company went bankrupt when it could not guarantee sales of 250,000 records every week.[18]

RCA Victor's management pursued cheap discs with increasing intensity as the Depression worsened. Victor engineers began studying Durium samples in the fall of 1929, and the professors' attempt to sell their business to RCA Victor in March 1930 spurred further investigation of the technology and its market.[19] The next month, F. C. Barton of the engineering department reported on efforts to manufacture resin-coated cardboard records that cured quickly without curling, wore well, flexed

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[18]"Demonstrate New Indestructible Record," TMWRMM, January 1930, 71, notes Bernard M. Baruch as one of the investors; "Paper-weight Unbreakable Phonograph Records: Is the 'Hit of the Week' Out Yet?" Scientific American, April 1930, 307-308; Sanjek, 119-20. Collectors report that the label continued until 1932 and was sold by mail as well: Nauck's Record Auction catalog, #26, closing November 6, 1999, 12.

[19]Barton, TR-112, p. 6; RCA Victor Board meeting minutes, March 6, 1930, p. 5, Young Papers, box 179, folder 321A. Research on the use of thermosetting resins had begun at Victor shortly after Leo Baekeland commercialized Bakelite, and in 1915 two engineers pressed records made of formalin. The cost of the material, compared to shellac compositions, discouraged its commercialization: Barton, p. 5.

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rather than shattered, generated no more noise than Durium or regular records, all at a competitive price.[20]

Barton's group resolved all but the curling and the cost, for in June the company ordered over 100,000 discs made instead of cellulose acetate for eight cents apiece. To maintain Victor's reputation and prices, these were to "be disposed of under a name other than Victor and through channels now handling records." The records, which played best with a dull stylus, represented a trial through which the company would gain a sense of response by its dealers, the experience of production with a new material, and the refinement of a new recording process.[21] In March 1931 its board approved formation of "Radiodisk, Inc." to sell "low-priced records to mail order houses, chainstores, etc." under "a more suitable name."[22] Over a year later, in the summer of 1932, the Camden plant began pressing eight-inch "Electradisk" and "Bluebird" records. In August RCA won the contract to provide the F. W. Woolworth Company's eighteen hundred stores with dime records. In September

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[20]Barton, TR-112, especially p. 18, where Barton never settled on a cardboard sealant that could be applied effectively in production.

[21]The company abandoned the Western Electric process that year: RCA Victor Board meeting minutes, June 19, 1930, p. 2, Young Papers, box 179, folder 321.

[22]RCA Victor Board meeting minutes, March 5, 1931, p. 2, Young Papers, box 179, folder 321.

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the Company announced its own ten-inch, ten-cent Electradisk records, and began selling ten-inch Bluebirds through Woolworth's the following March.[23]

B. New Features

`In the fall of 1930 RCA added home recording to its line of Victor and Radiola phonographs. As the company's executives explained, the microphone and six-inch, two-sided discs of cellulose acetate meant that "audible snapshots" of "the family reunions, the memories of aged parents and every memorable event of the home can be retained and cherished as a living album of memory."[24] The editor of Electronics magazine recognized the noisiness of the recording blanks but hoped that some of the thousands of users would help make "unlooked for improvements"[25] One writer in The Phonograph Monthly Review thought that music lovers still critical of electrical recording would

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[23]Alan Sutton, Directory of American Disc Record Brands and Manufacturers, 1891-1943, (Westport, Conn.: 1994), 18, 56-57; Sanjek, 121.

[24]First quote from "Home Recording is Victor Development," RMM, August 1930, 64; second and third quotes from "Home Recording Gives Radiola Three Uses," RMM, September 1930, 24.

[25]"Home Recording Devices May Point [to] New Methods," Electronics, November 1930, 393.

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discover through use of the microphone that it, like acoustic, "has a technique very much its own."[26]

The feature was not a success. Home recording resurrected the challenges of the previous century, and it proved no easier to develop a record delicate enough to take a detailed tracing of the soundwave and tough enough to resist the wear of the playback stylus. The Presto Record Maker, which sold for $85 and attached to a radio for recording and reproduction, used a two-pound recording head to emboss aluminum discs. Customers played back their recordings with a fiber stylus, but the weak turntable motor, noisy amplifier, and resonant tone arm did "not indicate well planned development or even careful thought to the many details necessary for satisfactory home recording."[27]

The recording equipment designed for high-end radio-phonograph combinations benefitted from development of the "phonogram" as a commercial project, and RCA engineers from three sections collaborated on more appropriate mechanisms and record material. Nonetheless, cost pressures on both projects forced a switch

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[26]R. D. D., "Editorial," PMR, December 1930, 74.

[27]Karns, "The Presto Record Maker," RCA Victor Engineering Department TR-114, p. 6, Hagley 2069, series XXI, box 115.

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from a blue-tinted lacquer blank to a pre-grooved cellulose-based disc.[28] During two years of promotion engineers improved the playing time for its six- and ten-inch discs from one and a quarter and three minutes up to four and ten minutes, respectively.[29] To gain this time, however, engineers accepted the increased distortion that came with recording at 33 1/3-rpm. Low sales forced the company to finally withdraw it from the market.

C. Continuity through Changers

The competition with radio did not rest on price alone. Radio reception suffered from distortion and noise never heard in phonographs, but radio offered one quality that phonograph engineers struggled to match: playing time. Engineers who tried to replicate

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[28]See A. G. Zimmerman, "Phonogram," RCA Victor Engineering Department TR-79, November 28, 1930, pp. 7-8, and E. W. Engstrom, "Desk Type Commercial Phonogram (For Pregrooved Records)." RCA Victor Design Specification DS-142, August 28, 1930, both in Hagley 2069, series XXI, box 115.

[29]M. E. Karns, "The Presto Record Maker," TR-114, p. 5, Hagley 2069, box ; "RCA Victor Steps Ahead in 1932," RCA Victor brochure, Hagley 2069, Historian's series VI, box 15 (oversize), folder 10; "Home Recording Apparatus Gains Popularity As Its Many Uses Are Realized," RCA News (April 1932), 20, David Sarnoff Library, Princeton, N.J. (hereafter DSL).

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continuity on a record player faced a number of challenges.[30] The record industry had never standardized the 78. The blades on a changer needed to separate a record from a stack of discs ran into different thicknesses and edges ranging from tapered to squarecut. The tonearm required a motor powerful enough to reverse its momentum and move the mass of the arm as it finished a record and then prepared to cue up on the next one. The turntable motor had to be strong enough to maintain speed while bearing the weight of records stacked upon the spindle. If the records dropped in a stack on the turntable, then the tonearm also had to cue at a height above each successive disc. If the mechanism removed the records, then more machinery and space was required to place the records elsewhere, gently, in the phonograph cabinet.

Victor introduced the first record changer in 1927, a $600 Orthophonic machine designed by Benjamin Carson that played one side of each of twelve discs. This represented the low end of the company's line of changers, none of which could play combinations of ten-inch or twelve-inch records. The next year Victor introduced another changer mechanism that could play a mix of popular and longer performances. Unlike the first model, which "worked slowly but faultlessly," the 1928

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[30]See the variety of changers on the market in Franklin S. Irby, "Developments in Automatic Record Changers," Electronics, April 1931, 584-86, 612.

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model "gave a tremendous amount of trouble . . . . and created a lot of ill will."[31]

Others stepped in, most notably Homer E. Capehart.[32] A boundlessly optimistic Hoosier who sold popcorn makers, Capehart met in 1927 a Cleveland inventor, Thomas Small, who had patented a phonograph that played twenty-eight records on both sides until it was turned off. Capehart saw this as a natural complement for establishments selling popcorn. He organized the Capehart Automatic Phonograph Company (CAPC), and sold "Orchestrope" jukeboxes for

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[31]First quote from Robert W. Baumbach, Look for the Dog: The Victor Talking Machine Companion, 4th ed. (Woodland Hills, Calif.: 1994), 217; second from "RCA Victor's Overall Automatic Record Changer Activity by Changer Mechanism," October 2, 1945, 1, Hagley 2069, Historian's series VI, box 9, folder 45.

[32]For other entries in the record changer market, see "Electromatic Is Placed on Market," TMWRMM June 1930, 150; ad for Electromatic changer, RMM, October 1930, 111; full-page ads for Allen-Hough Carryola's automatic record changer, RMM, September 1930, 17, and October 1930, 17; "Coin-Operated Record-Changing Device Marketed by Allen-Hough,"RMM, January 1931, 82; "Phono-Radio Survey: Columbia Automatic Phonograph and Radio Model 991," PMR, December 1930, 81; "The 1930-1931 Phono-Radio Models: Brunswick Automatic Model 42," PMR, October 1930, 15; ad for Brunswick Automatic Panatrope-with-Radio, cover of RMM, January 1931; "'Automatic' Business Continues Unabated in Face of Conditions," RMM, February 1931, 84; "Don T. Allen Making Business Trip Abroad," RMM, October 1930, 67. Katharine Hepburn, in Me: Stories of My Life (New York: 1991), 154, relates how her husband, engineer Ludlow Ogden Smith, never patented the improvement he made to Victor's first changer, much to her annoyance. My thanks to Mr. Gordon Stott for this last reference.

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$500-1,000 to speakeasies and bordellos across the country. In 1929 Capehart grossed $4 million but, in a sign of the costliness of the technology, lost money.[33]

Under pressure from his investors, Capehart acquired the changer patents of a Columbia engineer, Ralph Erbe, and began marketing the Capehart 16-E radio-phonograph-changer to wealthy households in January 1931. Despite a series of articles in the industry trade magazine and some celebrity purchasers, CAPC's losses doubled between 1930 and 1931. In desperation from debt of nearly $2 million, Capehart tried to sell the rights to the 16-E in 1932 to RCA Victor which refused, having had its own problems profiting from the high-end market.[34]

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[33]"The Capehart," Fortune, February 1941, 62-64, 119; William B. Pickett, "Homer E. Capehart: Phonograph Entrepreneur," Indiana Magazine of History LXXXII (September 1986): 268-69. Pickett based his article on his doctoral dissertation, "Homer E. Capehart: The Making of a Hoosier Senator" (Indiana University, Bloomington, 1974).

[34]"The Capehart," 119; advertisement for a "Marvelous New Automatic Record Changer for the Home," RMM, January 1931, 25-26; "Capehart Announces New Automatic Record-Changing Device," RMM, January 1931, 48. For articles, see Capehart's comments in "Leaders Outlook," TMWRMM, January 1930, 16; "Capehart Corp. Inaugurates Record Classification Service," TMWRMM, July 1930, 42; H. E. Capehart, "Opening the Door to More Profits," RMM, September 1930, 93; T. J. Hicklin, "Repeat Profits from Records," RMM November 1930, 42; "Capehart Field Staff Confers at Factory," RMM, November 1930, 46; "Automatic Combination Instrument Restoring Business of Olden Days," RMM, December 1930, 76.

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Driven from his own company, Capehart set up another before joining the Wurlitzer Company. He brought with him another patent for a mechanism that let jukebox patrons choose their discs rather than accept the next one in the stack. Four years passed before Wurlitzer profited from the new jukeboxes, and not until 1940 did Capehart's own company turn a profit, based on royalties from a cross-licensing agreement with RCA and a cheaper changer that did not turn over the records.[35]

Although by the mid-1930s record changers gained enough of a market to lure other manufacturers, the prices charged for the most reliable devices never paid for the costs of production, justifying RCA's rejections of Capehart's patents.[36] For all of their appeal in continuity,

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[35]"Charles M. Niezer Elected President of Capehart Corp.," RMM, February 1932, 54; "Increased Production for Packard Record Changer," RMM, December 1932, 34; Pickett, 273; "The Capehart," 64, 120. After RCA Victor again rejected an offer to sell the Capehart assets in 1935, the Farnsworth Television & Radio Company bought out the company in 1938. Farnsworth and RCA signed the cross-licensing agreement in 1939; RCA gained access to the Capehart patents as well Philo Farnsworth's basic patents on television camera tubes. In 1941-42, it produced 6,502 of its own $375 version of the 16-E, the V225, which, like Victor's own mechanisms, "gave a great deal of trouble": "RCA Victor's Overall Automatic Record Changer Activity," p. 4.

[36]RCA Victor's Ben Aldridge advocated that RCA develop a changer similar to Capehart's after a tour of RCA's distributors early in 1935: "Distributors' Statistical Control, 1935," Hagley 2069, Historian's series VI, box 9, folder 23.

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record changers never found an audience that could afford their utility. The expense of a mechanism that did not need frequent adjustment limited it to affluent adults. Because the changers played one side of each record in a stack before a listener turned it over, manufacturers had to make and dealers had to stock two sets of albums: one for those with changers, and one for those who turned over each record in turn. By the end of the 1930s, the company provided the mass market with cheaper machines, but their struggles with other labels' discs tarnished the company's reputation for quality.

D. The Consumer Response

While the mass market expressed its opinion of the phonograph through sales volume, one group within it expressed itself in print. Almost all male and apparently unmarried, "music lovers" or "phonophiles" as they identified themselves, commented in The Phonograph Monthly Review (PMR) on far more than the virtues and aesthetics of recordings. By the late 1920s the problem of companies changing the tempo of a classical performance to make it fit an even number of sides had subsided, although this contributed to the problem of what to put on the last side of an album.[37] Like other record buyers, however, they encountered uncaring dealers and poor distribution

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[37]Karl Wendell, "Odd Sides," PMR, September 1931, 322.

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systems, which music lovers attributed to the radio industry's interest in retarding the phonograph industry.[38] When it came to the business and technology of the phonograph, the difference between music lovers and the general public was that music lovers took the time to express themselves for posterity.

Like other middle-class buyers, the music lovers contended with limited budgets that could not accomodate changers or gimmicks. Nor were they so young as to embrace the content of a cheaply made record for the sake of price. Instead they concerned themselves with more mundane issues, like the search for a less abrasive alternative to the steel needle and the problem of warped records. Solutions like "Burmese Colour" or "Waltone Graphite" needles and "Aladinite" lubricant could be abandoned if the domestic industry would "devise a simple, semi-permanent needle."[39]

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[38]Paul Lewinson to the editor: "Propaganda--Prices--Merchandizing," PMR, June 1931, 287-88; Edw. J. Allen to the editor: "A Diagnosis of Phonograph Ills," PMR, June 1931, 267; A. J. Franck to the editor: "Some Problems and a Program," PMR, July 1931, 288-9.

[39]H. E. Kleist to the editor: "A Searching Analysis," PMR, September 1931, 327. For more on needles, see Richardson Brown to the editor: "Burmese Color Needles," PMR, June 1931, 232; Otto Schneider, "For Better Gramophone Music," PMR, November 1931, 39-40; R. D. D. [Ronald Darrell], "Editorial," PMR, November 1930, 39; R. H. S. P., review of Victor discs 9789-90, "Mozart's Serenade (Eine Kleine Nachtmusik)" and Henry Purcell's "Hornpipe," played by John Barbirolli's chamber orchestra, PMR, November 1930, 60; Henry R.Hubbard to the editor,

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The other problem concerned the records themselves. Columbia's laminated discs, noted for their quiet surfaces, were prone to warping.[40] All records suffered from erratic centering. Manufacturers punched the spindle hole in a process separate from pressing the disc, and any sloppiness in placing the disc under the drill press resulted in "wow" and pitch distortion. It was a subject that received periodic attention among the music lovers, one of whom found that a third of his Red Seal purchases were poorly or "scandalously" centered, and another third only "passably."[41]

The music lovers enjoyed better sound, but they found that electrical recording and reproduction remained a debatable progression. Writers noted the erratic quality of such discs and concluded that half an improvement was often sufficient. Records dating back to 1905 sounded "very well indeed" when played back on an Orthophonic Victrola: Karl

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PMR, December 1930, 84; "New Needles," PMR, May 1931, 232.

[40]Kleist to the editor, 327. In environments where the temperature and humidity varied widely, e.g. warehouses, the layers comprising Columbia's records swelled and contracted at different rates and volumes.

[41]H. C. A. to the editor: "Correct Centering," PMR, June 1931, 266; see also Ben Drisko, "Problems of Sound Reproduction," PMR, June 1931, 262, n. 3; Edwin C. Harrolds to the editor: "Lessons Learned in the Crisis," PMR, August 1931, 307; and John E. Nieland to the editor, The Music Lovers' Guide (hereafter MLG) June 1934, 300.

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Muck's rendition of Tchaikovsky's Fourth Symphony "remains . . . one of the most glorious discs yet recorded."[42] Electrical or Orthophonic reproduction appeared to expand the dynamic range of acoustic recordings, but for performers like Caruso who never sang to a microphone, "the greatness of the tenor voice will compensate you for the brilliance which is the outstanding feature of the electrical process."[43]

Finally and most importantly, the music lovers could not understand why manufacturers continued to treat the phonograph as a luxury and not a staple of American culture. Editor Ronald Darrell inveighed against companies that bombarded the public with a "succession of 'perfect' machines rendered obsolete within a year by a super-perfection." He called on the industry to cater to the record buyers: "Put out a turntable pickup outfit for plugging into a radio at a retail price of less than $20. Sell them at bare cost if necessary, but get them out to musically minded people, and thus create a larger market for discs."[44] Readers agreed, one recalling a dealer who had tried for years to convince

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[42]First quote from Ricardo M. Aleman, "Vocal Recording Standards," PMR, November 1930, 78-79; second quote from Jean-Louis, "Conserving Musical Values," PMR, July 1931, 285.

[43]Richardson Brown to the editor: "R. B. Reports on the new Columbia Radio-Phonograph," PMR, March 1931, 183.

[44]R. D. Darrell, "Some Phonographic Ills," PMR, June 1931, 258.

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manufacturers to cater "to the large number of middle-class 'prospects' who are genuine music lovers." Instead, "the companies . . . devise elaborate 'automatic' machines . . . in enormous cabinets which few people can house, playing only one brand of records effectively. . . . Is this the lesson taught by . . . Mr. Ford?"[45]

Section V: Giving Consumers What They do not Want: the Long-Playing Record, 1931-1932

The pleas of the music lovers fell on deaf ears at RCA Victor, where the next effort to revive the phonograph business lay firmly within the tradition of Eldridge Johnson's exploitation of the luxury market. The longplaying record offered the advantage of a technology Victor already made and sold in other applications. The Record Department's management believed that longer playing records "must be produced if the phonograph is to continue to exist on a commercial scale." Besides answering the competition for listener's ears, the new records would require consumers to buy phonographs that could play them, unlike the Orthophonic discs, which consumers continued to play on old machines.

The concept was not new. Edison introduced a twelve-inch vertically cut disc that played forty minutes at 33 1/3-rpm on a side in

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[45]Lewinson to the editor, PMR, July 1931, 287; see also W. C. P. to the editor: "A Typical Reaction," PMR, August 1931, 308.

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1928, but the four hundred grooves per inch proved too delicate for the tonearm to track. Victor had been making records of similar speed since 1926 for Warner Brothers' Vitaphone talking pictures, but these were sixteen-inch discs that played at the same speed for fifteen minutes, the length of a film reel. They were also produced for radio broadcasts and RCA's "practical minded engineers" adapted this system for consumer use.

To ensure its success with consumers, they made several assumptions. To maintain the present audience for the technology, they retained enough compatibility to use a stylus of the same radius as for 78s and add the second speed to 78-rpm record players in the new phonographs. As each record became more valuable, the engineers stipulated that it be less fragile than the current disc. This required a new material, which the Carbide and Carbon Chemicals Corporation had coincidentally offered to Victor in the spring of 1930.[46]

Vinyl chloride-vinyl acetate copolymer had its origins in a search for synthetic tung oil in 1925. Because tung oil contains vinyl groups,

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[46]Cellulose acetate had been used for cheap novelty records in the early 1920s, and for Bell Labs' high fidelity recordings in the early 1930s, but it turned out to have two disadvantages. One was its tendency to absorb moisture in humid conditions. Second, as the stabilizer evaporated over time, the records hydrolyzed, precipitating the plasticizer as a liquid on the disc surfaces and warping the record: Arthur Keller, Recollections of a Stereo Pioneer (San Francisco: 1983), 19.

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Union Carbide's Joseph Davidson tried polymerizing vinyl chloride, which resulted in a thermoplastic suited to molding. Copolymerization in a proportion of 87-13 with vinyl acetate improved its resistance to heat and light, and after beginning pilot production in 1929, Davidson contacted RCA Victor's Record Division to offer the product as a subsititute for shellac.[47] After a year's collaboration with Carbide's chemical engineers, RCA Victor's Frederick C. Barton introduced the first vinyl discs to the motion picture industry in the spring of 1931.[48] To maintain corporate identification and market familiarity with the material, Victor christened it "Victrolac." That September the company bought an exclusive license for 300,000 pounds of Vinylite V at eighty-

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[47]I have synthesized this chronology from "Carbide & Carbon Chemical," Fortune, July 1941, 66; A. F. Randolph, "Economic and Engineering Trends in Plastics," Chemical and Metallurgical Engineering (hereafter CME), January 1937, 28; "Chemical Engineering Marches On!," CME, May 1933, 231; "Plastics Use Moderate Decline to Plan Ahead," CME, January 1931, 54; John D. Benedito, "What Vinylite Plastics Mean for the Recording Industry," in Neil Harrison, ed., Record Retailing Yearbook (New York: 1949), 24; Joseph G. Davidson, "Petrochemical Survey: An Anecdotal Reminiscence," Chemistry and Industry, May 19, 1956, 395. My thanks to Dr. Jeffrey Meikle, University of Texas, Austin, for this last citation.

[48]F. C. Barton, "Victrolac Records," Journal of the Society of Motion Picture Engineers XVIII, no. 4 (April 1932): 452-53.

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three cents per pound from the Carbide and Carbon Chemicals Corporation, and retained an option for twice that amount.[49]

The substitution of manmade for natural plastic had several advantages. Pure Vinylite records eliminated the "needle scratch" associated with the mineral powders in traditional records. No longer would recording engineers have to record at a high level in order to boost the recorded sound over the background rasp. Since the tonearm did not need the mass necessary to track the amplitude of high-level recordings, engineers reduced the weight of the pickup from six to three ounces. The reduction in soundwave amplitude permitted a denser pitch of grooves per inch; along with the slower playing speed, this gave the records more playing time.[50]

This did not mean that Victor could convert to pure plastic. Executives and engineers agreed that a longplaying version of a

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[49] RCA Victor Board meeting minutes, September 18, 1931, Young Papers, box 179, folder 321. Carbide and Carbon produced a number of "Vinylites" based on different polymers, including Vinylite A for polyvinyl acetate, Vinylite Q for polyvinyl chloride, and Vinylite X for polyvinyl butyral: F. L. Creagher, "Plastics," Scanner 5, no. 2 (April-June 1940): 12.

[50] F. C. Barton, "Victrolac Motion Picture Records," 453-56; Charles M. Burrill, "A Survey of the Phonograph System for Sound Reproduction in the Home," RCA Victor TR-183, January 25, 1933, p. 27, Hagley 2069, series XXI, box 116. Barton refers to older pickups weighing five ounces, but he may be referring to the theatrical version.

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performance should be cheaper than the equivalent album of 78s. Vinylite cost more than shellac and slate powder, and RCA Victor diluted it with clay particles. This reduced the cost and also maintained the durability of the discs under the three-ounce pickup. The less abrasive blend meant allowed engineers to fulfill one consumer wish: a chromium-plated needle good for twenty-five plays.[51] The records were also seventy-five percent lighter than shellac records and far less brittle.[52]

RCA Victor's management also saw the transfer from commercial to mass markets as an opportunity to assuage its middlemen who thought the company should focus on radio. When the company began consolidating its Victor and Radiola Divisions late in 1930, it gave the top rated distributor in each territory the option of buying out its competition, which led to "difficult and protracted" negotiations.[53] The survivors, mostly from the radio side of the business, compared the RCA line to that of the Philadelphia Storage Battery Company. Based across the river from Camden, Philco had become the leading radio company

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[51]For more on the chromium needle, see C. M. Burrill, "A Survey of the Phonograph System for Sound Reproduction," RCA Victor TR-183, Hagley 2069, series XXI, box 116, p. 12.

[52]Barton, "Victrolac Motion Picture Records," 454-55.

[53][B. L. Aldridge], "Confidential History of RCA Victor," p. 76, Hagley 2069, Historian's series, box 1, folder 3.

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through the production and sale of cheap, table-top radios.[54] Given the industry's trend toward discounting, RCA's resistance led distributors to assume that the acquisition of the Camden plant and its phonograph facilities amounted to a "white elephant" inflicting "terrific overhead" on its products.[55]

Victor denied that this was the case. Sales executives tried to explain the systems nature of the phonograph, where dealers sold and profited from the content that broadcasters provided for free to radio buyers. The company offered incentive and sales programs that harkened back to the success of the Orthophonic promotion.[56] The centerpiece of their argument, the longplaying record system, represented an equivalent innovation.

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[54]For Philco's rise, see "1,250,000 Out of 4,200,000 U. S. Radios," Fortune, February 1935, 75-79, 164-73.

[55]"Presentation of the New 1931 Line--RCA Victor Co. Inc.--August & September, 1931," draft of Ernest H. Vogel's speech to Pittsburgh dealers, August 12, 1931, 5, Hagley 2069, Historian's series VI, box 10, folder 15: "Sales and Marketing Materials, 1931."

[56]See R. P. Wetherald, Manager, Record Promotion, RCA Victor, to All District Managers, February 16, 1931, Hagley 2069, Historian's series VI, box 9, folder 36; "Complete Program Data: Victor Dealer Meetings for the Introduction of the 1931 Line," part VI: "Sales Records Through Record Sales," containing the text of H. S. Maraniss's address to major dealers, c. summer 1931, Hagley 2069, Historian's series VI, box 10, folder 15.

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The new longplaying records, ten and twelve inches in diameter, were debuted at the Savoy-Plaza Hotel in Manhattan on September 17, 1931. Sarnoff, Victor president Edward E. Shumaker, and RCA vice president of engineering Alfred Goldsmith appeared and gave the innovation their blessing. So too did John Philip Sousa, who heard with the rest of the assemblage of performers, editors, executives, and educators a comparative history of disc phonograph development. It began with Berliner's handcranked machine and a Sousa march that sounded like "an indistinguishable squeak of varying pitch" and concluded with a movement from Beethoven's Fifth Symphony on an Orthophonic Victrola that ended more abruptly than the composer intended. Then the hosts presented "a massive home entertainment instrument" on which they played a "program transcription." This new term aligned the record with its broadcast origins and distinguished it from the fragmentary character of 78s. The new record of the Fifth by Leopold Stokowski and the Philadelphia Orchestra surpassed the four 78s of the earlier recording in terms of convenience and its "remarkable tonal quality."[57]

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[57]"RCA Victor Introduces the New Long-Playing Record," RMM, October 1931, 34.

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This was one of two original recordings made that summer. Victor's chief recording engineer Raymond Sooy oversaw longplaying recordings of the symphony and Leo Reisman's score for the musical, The Band Wagon.[58] The discs played up to fifteen minutes on a side at 33 1/3-rpm. Combined with the $95,000 record changer developed for the system, listeners could hear over two hours of music, including "thirty-four of the better known classical and semiclassical compositions."[59] The other thirty-two were rerecorded and segued together from 78-rpm masters.

Section V: Whither High Fidelity?

> "The requirements as to frequency range and freedom from distortion for any particular service are, in the last analysis, determined by public demand."[60]

Most noticeable about the innovations offered to consumers during the Depression is the lack of claims for better sound. This was not due to a lack of effort on the part of producers. The term "high fidelity"

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[58]Sanjek, 120.

[59]Barton, "Victrolac Records," 453-54; "Meeting Minutes of the RCA Victor Board of Directors," January 8, 1931, p. 1, Young Papers, box 179, folder 321: "RCA Victor Meeting Minutes to January 1, 1933."

[60]E. O. Scriven, "Auditory Perspective--Amplifiers," Electrical Engineering, January 1934, 25.

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had its start in the United States in 1931 when RCA Victor's Irving Wolff demonstrated a "high fidelity system" that included a phonograph. O. H. Caldwell, editor of Electronics magazine, made the transition from "tone" to "fidelity" to "high fidelity" in his May editorial when he included it as a defining element of the new "midget" radios flooding the market.[61] Caldwell regarded better sound as the salvation of the radio industry, where production capacity and the Depression moved manufacturers to order engineers to make radios as cheaply as possible.[62] Supported by manufacturers of better quality equipment, his magazine became the venue for articles warning of the cost for the industry when consumers realized the difference in "tone fidelity" or "tone quality" between radio transmitters and movie theaters on the one hand and radio receivers on the other.[63]

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[61]Loren F. Jones, "The Specific Transmitter Performance Required for High Fidelity," Broadcast News, February 1935, 8; "Some Fundamental Specifications for the Midget," Electronics, May 1931, 615.

[62]"Price alone controls the purchase and sale of component parts according to engineers responsible for making the majority of the 4,000,000 receivers . . . made and sold this year": quote from "Technical Trends Seen at RMA Trade Show," Electronics, July 1931, 6; editorial: "Higher Fidelity Standards Are Here!" Electronics, June 1932, 185.

[63]"The Dollar Value of Tone Fidelity," Electronics, May 1931, 616-17; W. Roy McCanne, "The Dollar Cost of Tone Quality," Electronics, September 1931, 97-98. McCanne was president of Stromberg Carlson Telephone Manufacturing Company.

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Perhaps consumers did weigh the difference in the sound of a movie theater and their radios, but they also recognized the difference between an auditorium and their living rooms. In the household, they could only compare the qualities of the telephone, phonograph, and radio as sound-reproducing media. Coincidentally, these had similar ranges of reproducible frequency. The radio networks used telephone lines designed for speech reproduction for linkage, stations could broadcast a maximum of 5,000 cps thanks to bandwidth limitations set by the Federal Radio Commission, and the surface noise of phonograph records limited reproduction to about 4,500 cps. In addition, the superheterodyne circuit that enabled precise tuning of stations limited high-frequency reception while the introduction of pentode amplification tended to distort what high-frequency signals a listener did pick up. Finally, no one could overcome the preference for artificial bass emphasis in radios that early generations of listeners sought in phonographs.[64]

Thus Victor showed more audacity in its campaign during the run-up to the Christmas 1929 season than industry observers imagined. "Victor Tone Week" encouraged prospects to sample "an intangible

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[64]"The Dollar Value of Tone Fidelity," 616; "Technical Trends Seen," 6; "Survey of 1932 Radio Trends," Electronics, October 1931, 136.

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product, namely, the importance of tone." In conjunction with RCA's network, the National Broadcasting Company (NBC), on which Victor artists appeared, Victor promoted recordings of the performances. In 122 cities, advertisements explained "the facts about tone quality," which booklets described in twenty questions. Since this was in part "an education program," one writer credited the company for devoting a "full week" to raise consumer consciousness.[65]

Consumers took far longer to respond to the importance of sound quality. One jobber reported in the fall of 1930 that he was still selling some twenty thousand main springs a month for acoustic phonographs: not everyone was trading up to electric sound.[66] The new art deco cover of The Phonograph Monthly Review featured among abstract images of discs an acoustic tonearm and soundbox rather than an electical pickup.[67]

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[65]First quote and ad quoted in "Victor Plans to Sample the Intangible," Printers' Ink, November 28, 1929, 149.

[66]"Mr. Fuhri on Record Business." PMR, November 1930, 41.

[67]Noted also in Henry S. Gerstle to the editor: "Gerstlean Comment," PMR, November 1930, 49.

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The obsession with fiber styli among music lovers indicated that they had yet to adopt electrically amplified phonographs.[68]

RCA's changes in marketing and the emphasis on radio by the electronics industry did not help the sale of phonographs. The Talking Machine Division of RCA Victor emphasized its own line of "Micro-synchronous" radios. Ads emphasized new radio consoles and tie-ins with the RCA-Victor Hour broadcast by NBC.[69] A regional follow-up to the December promotional campaign became "Victor Radio Tone Week."[70] Victor's marketing of its radio helped accelerate the assumption by dealers--and, through them, the public--that the leading phonograph company had moved away from records as an entertainment medium. Dealers who still sold records began carrying stocks from other companies, and the tail-out groove on the Brunswick records they sold did not trip the Victor changer mechanism.[71]

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[68]Charles Burrill, "A Survey of the Phonograph System for Sound Reproduction in the Home, Part I--The Recording System," RCA Victor TR-176, October 31, 1932, p. 14, Hagley 2069, series XXI, box 116.

[69]See two-page ad, "1930 . . . Stability--And Profits with the Dollar Sign. . . Not with a Question Mark," TMWRMM, January 1930, 20-21.

[70]"Victor Radio Tone Week in Pittsburgh," TMWRMM, January 1930, 75.

[71]J. G. Puterbaugh[?] to David Saranoff [sic], July 5, 1935, pp. 1, 4, Young Papers, box 149, folder 291A.

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As the Depression deepened, a disjunction arose between the marketing and engineering domains. Those men trying to sell the longplaying records took pains to assert their technical perfection. The opening statement of Victor's 1932 catalog noted the improvement of the label's records since the electrification and proclaimed the "enormous strides" made in 1931. "Scientifically speaking," there was "no room for further radical development in recording" although listeners could notice monthly improvement in the "fidelity, sonority and surface quality" of Victor discs. Indeed, they had "reached such a point in development as to make it reasonable to assume that it will never be necessary to remake records dating from 1931 onward, because of any possible future progress in recording."[72]

Those involved with the technology admitted how much more there was to learn. RCA's chief engineer Alfred Goldsmith, speaking on an NBC broadcast, predicted "longer playing records, reduced ground noise and increasingly silent background, and even wider tonal range with improved tone quality and an enlarged dynamic range with correspondingly increased dramatic value. The research workers . . .

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[72]Quoted in Oliver Read and Walter L. Welch, From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed. (Indianapolis: 1976), 291-92.

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struggling in the laboratory . . . are therefore really working for musicians and music lovers."[73]

Section VI: Selling the Luxury of Sound

Perhaps those who could afford the new system could afford not to worry about the future of the format. Only the new records were cheaper than their predecessors. Arturo Toscanini conducting Haydn's "Clock Symphony" sold for $4.50 on the longplaying disc as opposed to eight dollars in the conventional album of four 78s.[74] The cheapest longplaying phonograph, the RAE-59, retailed for $350, or $75 more than the Orthophonic Credenza six years before, and the RAE-79 for $995. Sales vice president E. A. Nicholas refused to apologize to distributors for the prices. The RAE-79, which included home recording, a nine-tube superheterodyne radio, dual amplifiers, twelve-inch electrodynamic speaker, and two-speed turntable, was "an instrument for the Elite . . . and we feel that even in the face of the economic times, there are thousands of such Connoisseurs . . . willing to pay the price." Those who could afford them also received "unquestionably the first absolutely fool-

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[73]"Dr. Goldsmith Talks on Sound Records' Future," RCA News, January 1932, 7, quote on 31.

[74]Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, rev. ed. (New York: 1965), 253-54.

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proof record-changing device that has been developed."[75] Besides, as one sales manager pointed out, more expensive machines reduced service costs and increased net profit, while richer customers offered less credit risk, "a mighty important factor these days."[76]

The price of the turntables, found only in radio-phonograph combinations, made little sense to historians in retrospect, particularly those devoted to classical music.[77] But a firm like RCA could not rest an innovation on a market where classical albums averaged sales of four to five hundred copies.[78] Even the PMR granted that the seven-disc, fourteen dollar Victor release of Beethoven's Symphony No. 3 in E Flat Major was limited to those who were "not plagued by considerations of a pecuniary nature . . . as [an] edition de luxe."[79] This was especially true

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[75]"RAE-79," Hagley 2069, Historian's series VI, box 10, folder 14: "Sales and Marketing Materials, 1931."

[76]"Presentation of the New 1931 Line - RCA Victor Co., Inc. - August & September 1931," pp. 9-10, Hagley 2069, Historian's series VI, box 10, folder 15.

[77]See Gelatt's proposed remedies for an effective longplaying marketing campaign, 254, and Read and Welch's criticism of RCA Victor's claims for the new records and styli, 291-93.

[78]Sanjek, 120.

[79]Review of "Beethoven's Symphony No. 3 in E Flat Major (Eroica)," Victor Musical Masterpiece Set M 115, PMR, January 1932, 75.

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when the innovation cut the price of the content nearly in half, with no guarantee of expanding the market.

RCA Victor followed the "most sensational announcement in the history of recorded music" with a newspaper and trade campaign. Ads used clock faces to highlight the difference between eight and thirty minutes of playing time (on two sides), and the difference in prices, which increased as the piece ran longer. Gilbert and Sullivan fans could purchase H. M. S. Pinafore on three discs for nine dollars instead of paying twenty-four dollars for twelve records that would not all fit on most changers. Victor urged dealers to "get your share" of profits on the "thousands . . . in fact, millions . . . of records" that would be sold. The company elided the fact that no extant phonograph could play the new records by making available a gear shift mechanism that "any qualified radio sevice man can install."[80]

By December 1931, as it became apparent that customers were not responding, the copy changed. Gone were the prices; now the copywriter suggested that the records made a "novel, entertaining, and inexpensive" Christmas gift anyone "will enjoy if they have a combination . . . that can play it." Two pages later, another RCAVictor ad wrote off 1931 and its

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[80]Full-page ad, "A New Era in recorded music has come," RMM, October 1931, 55; full-page ads, "New 30-minute record Going Over Big!," 19, and "RCA Victor Introduces . . .," 34, RMM, November 1931.

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products. Instead it encouraged to dealers to sign with the company by invoking the commercial traditions behind the RCA and Victor trademarks.[81]

When the new year began, RCA Victor's sales management convened its distributors to preview the 1932 line. By now Victor had combined all of its features--home recording, the "30 Minute Record Sensation," and a record changer enabling up to two hours of continuous music--which "put new life into the record business, and created thousands of prospects for sales of higher priced combination instruments."[82] As a further lure, the company announced plans for a popular longplaying record that would play on one side and provide three songs for eighty-five cents.[83] This record never appeared.

Unable to subsidize an elite format, Victor continued to release classical albums in 78 and 33 1/3 while raising the price of the longplaying sets, all dubbed, to between seventy-five and ninety percent of the 78

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[81]Full-page ads, "Just made for a Christmas Gift!" and "Look ahead with RCA Victor,"RMM, December 1931, 4 and 6 respectively.

[82]"The Voice of Radio Headquarters" (Camden, N.J.: RCA Victor Company, c. 1932), Hagley 2069, Historian's series VI, box 12 (oversize), folder 2.

[83]"RCA Victor Launches 'Step Ahead' Plan for the Radio Season of 1932," RCA News, January 1932, 30.

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albums.[84] It also continued to issue albums of 78s tailored for the music lovers who could no longer afford them. According to one marginally employed writer, these albums, especially the ten- to twenty-disc operas costing twenty to forty dollars, were "a prosperous man's hobby, or a hobby for a poor man with no family responsibilities."[85]

Section VII: Failing to Shape the Sound of Music: Technical Difficulties in Innovation

Perhaps consumers would have purchased more of the systems if they had worked as well as those they replaced. It turned out that the engineers designing the Victrolac records did not tell those designing the changers that the new discs were thinner than the shellac type. Consumers looking forward to two hours of continuous music found themselves fiddling with the changer mechanism after each record.[86]

A broader flaw in the phonographs lay in the challenge of reducing and maintaining the speed of the motor as its energy was

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[84]Review of Strauss's "Don Quixote--Fantastic Variations on a Theme of Knightly Character," opus 35, Victor Masterpiece (78-rpm) set M-144 and longplaying album consisting of records L-11633, L-11634, and L-11635-S, recorded April 1932, in MLG, October 1932, 46.

[85]Ulysses Walsh to the editor, MLG, September 1932, 12. See the opera album listings in MLG, April 1933, 246-47.

[86]"Trade Announcements and Price Changes," MLG, March 1934, 208. RCA Victor therefore switched to shellac for longplaying record albums but not for single longplaying releases.

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transferred to the turntable. At 33 1/3-rpm, fluctuations in speed, or "wow," became more noticeable than at 78-rpm. For the home players, the wow in playback was aggravated not only by the turntables on which the recordings were made, but also those on which the 78 masters were dubbed together at the slower speed.[87]

The motors generated other forms of distortion. The 1931 models used gears to transfer energy from the motor to the turntable, but they also transferred speed fluctuations and motor "rumble" or vibration. Despite the advantages a beltdriven turntable offered in silent, consistent operation, Victor engineers switched in 1932 to ball bearings for two-speed home phonographs.[88] In production, however, this form of propulsion demanded a level of precision assembly that proved difficult to maintain.

Finally, an initiative to double the frequency range of Victor Records had the result of reducing the range reproduced. In the winter of 1931-32, the recording group modified its equipment to extend the

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[87]E. W. Kellogg, "Linear Speed Tests of Phonograph Records," RCA Victor TR-245, October 22, 1934, p. 3, Hagley 2069, series XXI, box 117.

[88]"Two-Speed Turntables 79 rpm [sic] - 33-1/3 rpm," October 15, 1945, Hagley 2069, Historian's series VI, box 9, folder 45; E. W. Kellogg, "Minimizing Speed Fluctuations in Turntables," RCA Victor TR-340, November 19, 1936, pp. 4, 14-15, Hagley 2069, series XXI, box 118.

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upper frequency range from five thousand to ten thousand cps. To accomplish this they began limiting the amplitude, or intensity, of lower frequencies at two hundred cps rather than six hundred, and compensated by increasing the electrical amplification. The arrangement broke down when the recordists played back the new recordings on studio phonographs not designed to match the changes. They heard neither the low end with which they were familiar nor the high end, and consequently demanded even more low end emphasis in the recording equipment. For the consumer, this hardly mattered because none of the new phonographs was designed to exploit the change.[89]

Section VIII: Failing to Shape the Sound of Music: Commercial Difficulties in Innovation

After RCA Victor introduced the new format, Columbia and Brunswick announced that their versions would appear soon.[90] But the Depression and Victor's refusal to collaborate on a standard kept them from suppporting the new format. Brunswick, which was in the midst of changing ownership, disavowed interest in new formats and focused

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[89]Burrill, "A Survey, Part I," TR-176, pp. 27, 30, 44, 48.

[90]"Observer," "Program Transcriptions," PMR, October 1931, 3.

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on content.[91] H. C. Cox, president of Columbia Phonograph Company, criticized RCA Victor's innovation on technical and cultural grounds. The fifteen million turntables already used for 78s meant that the longplaying record was not yet "commercially practicable or a serious rival of the standard speed record." Therefore, "for a long time, the longplaying record will be chiefly useful in the field of classical music. . . . Even assuming the possibility . . . of making up combinations of two or more short musical compositions on long-playing discs . . . as would appeal to the tastes of a majority of users, it would take some years to build up an adequate repertoire." Echoing the slogan Victor had used years before, Cox concluded that popular music "must be in such form that users may select the titles they want without having to . . . pay for others they do not want."[92]

As an alternative, Cox announced that Columbia was developing "a practical form of long-playing record," which appeared in April 1932. His engineers obtained five minutes of playing time on a ten-inch disc by

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[91]See editor's note in response to H. C. Cox's letter, PMR, January 1932, 72; "Sees Future of Record Business at Brightest Since Peak Years," RMM, February 1932, 56, and an example of a full-page personality ad featuring Bing Crosby, RMM, May 1932, 16.

[92]H. C. Cox to the editor, PMR, January 1932, 72; reprinted in "Columbia President Discusses Phonograph Record Outlook," RMM, January 1932, 34.

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limiting the amplitude of the soundwaves and increasing the number of grooves per inch. Electric amplification and Columbia's laminated record surface maintained the volume of the music over the background noise, while use of waltz and foxtrot medleys emphasized a steady beat and obviated the need for wide dynamic range. These discs, touted as "longer playing" and compatible with standard phonographs, carried a special label and retailed for eighty-five cents.[93]

By July, after a change in management, Columbia followed RCA Victor's lead and embraced radio as a model for the phonograph's salvation.[94] Besides expanding into radio production, the company invested in the compatible same-speed field with what it called a "radio-record" and a "radiograph" on which to play it. Twelve inches in diameter and costing $1.25, disc 56000-D featured seven minutes on each side of emcee Ted Lewis and singer Kate Smith hosting simulated radio shows. While this disc compared "favorably with good radio-programs"

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[93]Full-page ad, RMM, April 1932, 3; "Columbia Announces Longer Playing Record," RMM, April 1932, 30; Michael W. Sherman, and Kurt R. Nauck III, Note the Notes: An Illustrated History of the Columbia Record Label, 1901-1958 (Dallas: 1998), 61.

[94]"New Columbia Executives Are Optimistic Over Outlook," RMM, May 1932, 65.

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it did not give "recorded music a new lease on life" because Columbia could not afford to follow up with other releases.[95]

Section IX: Failing to Shape the Sound: Consumer Complaints

The longplaying record was an innovation music lovers knew had "been in the air for a long time."[96] But no one in the PMR mentioned the possibility until they heard of the summer recordings and the dealer meetings. Darrell knew that Victor and Columbia were working on the innovation, and until "film, steel wire, or paper band . . . can be brought within reasonable price limits, . . . a satisfactory long-playing disc" would constitute "the greatest possible boon to phonography today."[97] When Victor started marketing the new system, Darrell conferred "the most heartfelt congratulations" to "the engineers who have finally developed the long-playing records and instruments to the marketable stage" on behalf of the magazine "and every phonophile."[98]

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[95]Full-page ad, "Join Columbia on the road to Record Sales," Radio Merchant, July 1932, n.p.; quotes from full-page ad, Radio Merchant, August 1932, n.p.; "Columbia Announces Radio Records and Radiograph," Radio Merchant, August 1932, n.p.

[96]Harrolds to the editor, PMR, August 1931, 307.

[97]"Editorial Notes," PMR, August 1931, 301.

[98]"Editorial," PMR, October 1931, 1.

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Another columnist could only "guess wildly" at the "full significance" of Victor's innovation. He applauded "one of the supreme advantages of the new system," the ease with which Victor transferred old recordings to the new format. Even if it appeared "at a time of impaired public purchasing power," Victor's system revived the phonograph as a "serious competitor of the radio even in the field of popular music . . . without sacrificing any of the peculiar selective qualities of recorded music."[99] A dealer on Long Island had heard the records at Victor's plant in Camden and decried music lovers for being "hypercritical. . . . [R]ecords must be describable in superlatives to be casually acceptable."[100]

These writers reflected the interests of Victor and the industry. The readership felt differently. One correspondent pointed out that compositions like Ravel's Bolero, which already suffered from the breaks in the 78 album, would not lend themselves to transfer and therefore demanded new recordings.[101] Another noted the timing of the innovation and echoed suspicions that the radio industry was conspiring

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[99]"Observer," "Program Transcriptions," 3-5.

[100]A. J. F. [Franck] to the editor: "Some Plain Facts," PMR, March 1932, 112.

[101]V. C. to the editor: "The Long Playing Record," PMR, December 1931, 48.

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to choke off phonograph consumption by sowing uncertainty among consumers over future formats.[102] A third was "one of those" who held that the only successful longplaying record would use vertically cut grooves.[103] In general, the music lovers, much like the general public, were concerned less with the quality than the implications the new format had for their collections.[104]

Beyond the conflict between corporate and consumer perspectives, the new records suffered from comparison to traditional 78s and divided opinion about the utility of longplaying discs. Some music lovers, like the general public, appreciated edited versions of performances, which enabled one "(as impossible in concert) to drastically eliminate certain sections, the sheep adventure, for example," in Richard Strauss's Don Quixote. Others argued that the composer's intentions be kept intact for posterity, to which others rejoined that a recording represented only one performance. Therefore there was no harm in making the essence of the recording more convenient and inexpensive. Although others agreed

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[102]Theodore B. Hanna to the editor, PMR, January 1932, 70-71, referring to Franck to the editor, PMR, July 1931, 288.

[103]M. B. to the editor: "Praise for Mr. H. C. Cox President of the Clumbia Phonograph Co.," PMR, February 1932, 88.

[104]Charles R. Basin to the editor: "Mr. Basin on Combinations," PMR, February 1932, 89; A. J. F [Franck] to the editor, PMR, March 1932, 112.

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that listeners should not suffer a composer's indulgences, there was no little irony that a reviewer should hail a format designed to enable uninterrupted listening for the editing skills of the producers.[105]

With the commencement of sales to the public in October for the Christmas season, the new records attracted far more criticism.[106] Claims to the contrary, the vinyl wore out under the pressure of the pickup. The sound quality depended on the original recording. Only the Stokowski and Reisman performances had been recorded at the slower speed. The dubbed records lost much in the process. One critic wrote that one record lacked "in color, brilliancy, and character," that it was simultaneously "thin" and "flabby." Presumably referring to the 78 version, he declared that the recording lacked "the life of the original" and concluded that

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[105]Review for Don Quixote--Fantastic Variation on a Theme of Knightly Character, opus 35, Victor Masterpiece set M-144 or longplaying records L-11633-4 and L-11635-S, MLG, October 1932, 46. For another critic's review of editing practices, see Herman Klein, "When Old Arias Should Not be Cut," The Gramophone (February 1931), reprinted in William A. Moran, ed., Herman Klein and The Gramophone (Portland, Ore.: 1990), 313-14; John J. Honigmann, "What to look for in the Phonograph," MLG, October 1933, 42. For an opposing view, see Allan P. Stern to the editor, MLG, July 1933, 352. See also the review for Leopold Stokowski's arrangement of Wagner's Tristan und Isolde--Vorspiel, Liebesnacht, Liebestod: a Symphonic Synthesis, Victor Masterpiece Set M-154 and longplaying records L-11636 and L-11637, MLG, December 1932, 117-18, where the reviewer cites transitions on the 78-rpm sides.

[106]Sanjek, 120. Gelatt, 253, writes that the records went on sale in November, which would have presented dealers with less time for sales development before Christmas.

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"despite the great advantages these records have in their long-playing feature, we would prefer to put up with the nuisance of frequent record-changing and listen to the standard discs."[107]

The longplaying records have been derided ever since.[108] What the reviewers at PMR thought of the new discs, however, is unknown. The March 1932 issue was the last, by which time they had not received one of the new format. When publisher Axel B. Johnson resurrected his magazine as Music Lovers' Guide in the fall, the lead review each month featured the latest RCA Victor recording pressed in 78 and 33 formats. It does not appear that the MLG had either the longplaying records or a phonograph on which to play them, but the reviewer described the first

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[107]Reviewer quoted in Gelatt, 253. The reviews he cites seem to have come from The Gramophone, Compton Mackenzie's magazine in England, which relied less on industry advertising than its American counterparts.

[108]See Gelatt, 253-54, for contemporary criticism and retrospective second-guessing; also the comments by Read and Welch, 291-93, and Millard, America on Record: A History of Recorded Sound (N.Y.: 1995), 195. In light of Burrill's analysis of the mismatch between recorder and phonograph specifications after 1931, the comment of former RCA Victor Records manager Edward Wallerstein that the records would "probably sound pretty good" with a modern lightweight pickup makes more sense: Edward Wallerstein as told to Ward Botsford, "Creating the LP Record," High Fidelity, April 1976, 57.

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recording as "first rate."[109] Reviews of dubbed longplaying records finally appeared in 1933 and 1934, buried among other listings, and left the issue of sound quality ambiguous.[110]

Section X: The Fall of the Phonograph, 1932-1933

Despite the best efforts of the sales managers and salesmen, Victor made only 4,352 of the longplaying phonographs in two years. At the end of 1932 Victor offered its first picture discs. These six-inch 78-rpm albums targeted children, offering images of Winnie the Pooh and other storybook characters under a clear cellulose acetate surface. In order to retain the broader market, however, the company offered an equivalent set of black 78s at a discounted price.[111]

The fall of 1932 represented a watershed for the industry. With the evaporation of the market for records as home entertainment, some

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[109]John Alden Carpenter, Skyscrapers, Victor Masterpiece set M-130 or longplaying records L-11618 and L-10000, MLG, September 1932, 20.

[110]Reviews of Victor L-16028 featuring Bestor's and Reisman's orchestras, MLG, August 1933, 382, and of Wagner, Tannhauser--Overture and Venus--Music, RCA Victor longplaying records L-11747 and L-11748-D, MLG, March 1934, 211. The latter is described as a "rich tonal feast." As the reviewers noted the earlier releases, it is possible that the commentary stems from the 78s and not a hearing of the rerecording.

[111]Review of Fraser-Simpson's Winnie the Pooh, Christopher Robin Songs, Victor six-inch records no. 221-23, MLG, December 1932, 122.

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RCA executives questioned the point of persisting with records when radio stations played popular songs on request. A rumor circulated to the effect that the company was ready to sell the business for five million dollars.[112] As Sarnoff also planned on introducing television in 1932, retaining a commitment to a pre-electric technology seemed nonsensical.[113] The revival of Nipper for marketing the new "Bi-

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[112]The issue of RCA's attitude toward the phonograph during the Depression remains anecdotal. The rumor is recounted in "Case Report on RCA Victor Records: Exhibit A, Background Data on RCA Victor Records," p. 96, J. Walter Thompson Archives, Account Files, box 16, folder: "RCA Account History (records through 1977[?])," c. 1953, John W. Hartman Center for Sales, Advertising and Marketing History, Rare Book, Manuscript, and Special Collections Library, Duke University (hereafter JWT Archives). See also Julius Haber, "An Address Before RCA Victor Sales Representatives," September 1944, p. 14, RCA Corporate Public Relations Collection, RCA Historical Files, Victor folder, DSL; and C. A. Schicke, a recording industry executive, in Revolution in Sound: A Biography of the Recording Industry (Boston: 1974), 95.

Sarnoff always envisioned the phonograph as part of the electronic entertainment industry he wanted to create, but Owen D. Young among others had his reservations. I infer this from J. E. Harbord to E. W. Harden, August 31, 1925, Young Papers, box 87, folder 223Q, regarding board dissension on the value of the parent companies' phonograph rights; Owen D. Young to Paul Cravath, November 14, 1928 (not sent), Young Papers, box 149, folder 291; and correspondence between Young and Gerard Swope, May 1-15, 1929, Young Papers, box 149, folder 291, which suggests that RCA president Harbord felt as well that the purchase of Victor should not include the record business.

For early disc jockey requests, see record dealers' comments on radio station practices in "The Market for Records," RMM, May 1932, 28.

[113]For television rollout, see J. R. McDonough and W. R. G. Baker to David Sarnoff, August 11, 1931, p. 2, Young Papers, box 149, folder 291.

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Acoustic" combinations and rerecordings of Caruso discs reflected the return to the past. It was a clever feat to filter out the earlier orchestral accompaniment, extend the frequency range, and equalize some of the distortion from acoustic recording.[114] But nothing attracted buyers to records.

Victor failed to see that record buyer was "an entirely different breed from what it was even a decade ago." The era of opera stars, and their market, had passed, and with them the "great bonanza, get-rich-quick days of the phonograph."[115] The Caruso novelty occurred at the same time that an elegy for the phonograph appeared in the American Mercury.[116] The article established the basis for future analyses of the industry during the rise of home radio, but at the time it provoked a

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[114]"Re-recordings of Caruso's Voice Should Boom Record Sales," Radio Merchant, September 1932, 21, and ad on cover, Radio Merchant, October 1932. J. P. Maxfield worked with Victor engineers in the 1926-7 on electrifying the sound of Caruso's voice: "Records by: Special Experiment," November 17, 20, 1926, and May 21, 1927, BMG Archives. My thanks to Dr. Michael Biel, Morehead State University, for providing copies. For Nipper, see RCA Victor Radio ad on the covers of Radio Merchant, November, December 1932.

[115]First quote from R. D. Darrell, "The Good Companions," MLG, November 1932, 77. See also Nicholas Dietz to the editor, MLG, 78. Second quote from Darrell, "So the Phonograph is Dead!" MLG, October 1932, 35.

[116]Dane Yorke, "The Rise and Fall of the Phonograph," American Mercury, September 1932, 1-10.

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vision of a different role for the medium. R. D. Darrell called for "today's proponents . . . to forget the old dreams of super-mass production. Let the radio and television, movies and the tabloids have their mob publics. Popular entertainment will always have some place on records, but the real field of the phonograph is music, its true public the students and lovers of music. And it must be cultivated as such."[117]

The Depression distorted both the presentation and the reception of RCA Victor's system. Beyond the economic context and marketing miscalculations, phonograph operations at RCA had unique challenges that help explain some of the difficulties. The RCA Victor Company represented a new engineering and manufacturing organization, and in the early 1930s it represented the crux of antitrust action against the parent company which was not settled until November 1932. During the first year after the merger, it designed and made products not only for its own brand, but for those of the RCA Radiola, General Electric, Westinghouse, and Graybar Companies as well.[118] The chaos of serving five clients in competition during the Depression extended into the engineering sections as well. "About the only activity left relatively free was research," but that too was subject to building and administrative

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[117]Darrell, "So the Phonograph is Dead!" 37.

[118]Haber, "An Address," 13, DSL.

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relocations as well as competition among staff in the same fields drawn from RCA and its parent companies.[119] After sales plummeted in 1930, Sarnoff folded the Victor and Radiola divisions into the RCA Victor Company, leading to more internecine competition in research, management, and distribution.

The failure, while primarily economic, also revealed the paucity of knowledge on the behavior of recording and reproduction systems; the poverty of the strategy of marketing home entertainment as a luxury; and the need to cultivate a broader audience for records beyond the hits of the day. Finally, the failure had its cultural aspects. Victor had done little to cultivate an audience for the classical performances that served as the cornerstone of the new catalogue, and virtually ignored the music lovers who might have acted as early adopters and champions for the mass market.

Section XI: David Sarnoff and the Phonograph

David Sarnoff, for one, was not prepared to give up on the technology or the mass market.[120] In December 1932, he proposed to the

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[119]"Conversation with Dr. [Irving] Wolff," November 5-6, 1956, p. 2, interview probably conducted by Kenyon Kilbon, RCA Labs Historical Files, DSL.

[120]Axel B. Johnson reported that record manufacturers in "confidential interviews" showed "the utmost confidence in the . . . phonograph" and were "all planning big things for the coming season."

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head of the National Broadcasting Company (NBC) that the radio network promote a "hit of the week." Listeners could order from NBC "the low cost, unbreakable record recently developed at Camden" for twenty-five to fifty cents "as the case might be." NBC gained a mail order business; RCA Victor sold more records and new, cheap phonographs; the customer heard the record before buying it and "saved the energy of going" to a store. Sarnoff went on to suggest that NBC might end up with a subscriber list in which a million listeners paid a dollar a month to receive the weekly hits.[121]

Sarnoff knew he was "getting too enthusiastic" and that "someone in NBC and someone else at Camden" would explain why his plan would not work.[122] Presumably that someone explained the risk in alienating dealers, for RCA never acted on Sarnoff's suggestion. Along with his prodding of NBC to move into the phonograph transcription business for radio programs and advertisements, however, the memo

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See "Editorial," MLG, October 1932, 3, and George C. Jell's article on behalf of Columbia, "The Manufacturer's Point of View," MLG, September 1932, 5-6.

[121]David Sarnoff to M. H. Aylesworth, December 13, 1932, Young Papers, box 149, folder 291A.

[122]Ibid.

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indicates that Sarnoff remained committed to the phonograph as a medium complementary to radio sales and broadcasting.[123]

So too did the underlings who remained or now worked at RCA.[124] In June 1933, RCA Victor unveiled the largest mid-year sales campaign in its history, marking the first of five consecutive years in which it increased its advertising budget.[125] A month later the company hired Edward Wallerstein to run the Record Department. Coming from Brunswick Records, Wallerstein brought not only a respect for technical innovation but a great appreciation for the mass market. Unlike executives at Victor or Columbia conditioned by tradition to separate classical music and market the phonograph as a luxury item, Wallerstein understood that marketing could help condition and lead consumers

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[123]See Richard C. Patterson, jr., to David Sarnoff, September 27 and October 4, 1933, on "NBC Policy--Electrical Transcriptions," NBC Papers, Central Files Correspondence, box 21, folder 49: "Sarnoff, David, Sept.-Dec. 1933;" and "NBC Electrical Transcription Service: Its Growth and Volume," Central Files: Department Files, box 92c, folder 44: "Electrical Transcriptions, 1937," State Historical Society, Madison, Wisconsin (hereafter NBC Papers).

[124]See Robert Sobel, RCA (New York: 1986), 97-98, for examples of Sarnoff's rearrangement of RCA executives.

[125]"RCA Victor Challenges the Summer Slump," Printers' Ink, June 8, 1933, 24-25; Haber, "An Address," p. 14, DSL; "Phonograph Records: Recovery in the Musical Reproduction Business," The Index, Autumn 1940, 68. The latter article does not name the company increasing its budget but given the lack of competitive firms and the attention paid to RCA's role in the revival, I have inferred it.

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from cheaper players and popular music to better sounding phonographs and higher priced classical music.

Almost immediately, then, he pulled the longplaying phonographs off the market.[126] He heard most of the customer complaints about the rapid wear of the records, and the many problems in the system harmed the reputation of Victor and expensive innovations. Wallerstein would not encourage another such project unless it could live up to the standards of playing time, frequency range, and record wear proposed by Victor's engineers. For the rest of the decade, phonograph innovation at RCA Victor would be focused on improving everything but the record. The company continued to sell longplaying records in inventory, but by the mid-1930s consumers bought Red Seal and Black Seal discs made of "special grades of shellac plus filler and black pigment," just as they had at the turn of the century.[127]

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[126]Wallerstein, "Creating the LP Record," 57.

[127]E. Wallerstein, "How Records are Made," in "The Field Representatives' Training Course, 1935-36" (Camden, N.J.: RCA Manufacturig Co.), Hagley 2069, Historian's series VI, box 10, folder 5. Records were no longer included among applications for vinyl by the plastics industry despite the title of the following article: "Plastics Make New High in Records," CME, February 1936, 90.

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Section XII: Shaping Better Sound: What Engineers Needed to Know

At the same time RCA pursued R&D on the quality of phonograph sound. What would it take to provide better sound from records? In September 1932 Charles Burrill, an engineer not previously associated with phonograph research, was assigned the task of finding out. In two reports he summarized the performance of current systems, the components that limited performance, the gaps in fundamental knowledge, and a plan for improvement.[128]

Over 114 pages plus numerous charts and graphs, Burrill followed his charter. Engineering in this area had not advanced significantly since Harrison, Maxwell, and Kellogg first laid out the premises of electrical recording and reproduction in the mid-1920s. Burrill identified the sources of distortion and areas of ignorance in physical behavior from the noise of the recording studio and listener's room to microphone calibration, amplifier distortion, recorder and record characteristics, record manufacture, turntable motors, tracking distortion, and loudspeaker response.

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[128]Burrill, "A Survey, Part I," TR-176, and idem, "A Survey, Part II," TR-183.

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Some of these were common to radio, but Burrill highlighted those unique to the phonograph. As the music lovers had pointed out, surface noise and poor centering accounted for the bulk of sonic distraction. The solution appeared to be less stylus pressure since electric pickups obviated the need for mechanical pressure to amplify sound. Yet this was not as obvious as it appeared. In August 1931, J. M. Kendall of the Receiver Section compared a typical six-ounce pickup with one weighing half that. He concluded that the heavier mass provided better frequency response, less distortion, less needle scratch, and less tendency to jump grooves. The lighter pickup had the lone advantage of reduced needle and record wear.[129] Nonetheless, Victor had produced some quiet 78s and Burrill assumed that quantitative research could standardize the technique. Better production controls would resolve the centration issue.[130]

Other problems included the inconsistency in speed of the recording and reproducing turntables and the distortion caused by the difference in the paths traced by the reproducing and recording styluses.

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[129]J. M. Kendall, "Comparison of 3 oz. vs. 6 oz. Needle Bearing Force on 78 r.p.m. Record," RCA Victor Engineering Memorandum EM-1010 (originally NRJ-395), June 16, 1931, Hagley 2069, series XI, box 47.

[130]Burrill, "A Survey Part I," TR-176, 45-47, and idem, "A Survey, Part II," TR-183, 61.

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Burrill emphasized that this latter issue was probably the source of non-linear as well as linear distortion, and "experience" had shown that "the listener's tolerance of non-linear distortion decreases rapidly as the frequency range is extended to higher frequencies." Therefore, Victor's staff had to examine tracking if it wanted to achieve a higher fidelity to the source.[131]

If RCA Victor's engineers resolved the technical difficulties, what sort of sound would their phonographs reproduce? Burrill drew on the insights of a musician to posit that the company should be concerned with "creative" rather than "replica" sound production. Reproduction was not merely a matter of engineering, after all, but of commercial and cultural restrictions over which engineers had no control. The acoustics of listening rooms, as well as the monaural signal and the translation of the sound through the electronic system meant that "the sound we hope to reproduce in the living room never existed before at any point in the originating studio."[132]

RCA Victor's phonograph engineers, like the marketing staff, did not act in a vacuum. Sarnoff envisioned an integrated company developing, making, and selling electronically based multimedia

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[131]Burrill, "A Survey, Part II," TR-183, 61.

[132]Ibid., 63.

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products. While the Depression hampered his ambitions, the antitrust settlement separating RCA from its owners, General Electric and Westinghouse, gave Sarnoff's centralizing tendencies full reign. In 1934, in anticipation of the consolidation of the RCA Victor and Radiotron Companies into the RCA Manufacturing Company, he hired a new director of information to integrate promotion of RCA products.[133]

At Victor, phonograph engineers now worked in one building in Camden next to their peers concentrating on radio receivers--and after 1932, motion picture research--with whom they consulted and compared notes.[134] They also attended national conferences for radio and motion picture engineers, read and wrote articles for RCA and professional publications, and kept up with developments in acoustics, recording, and reproduction elsewhere through those meetings, journals, patent literature, and cross-licensing agreements.

Their peers, especially at Bell Telephone Laboratories, pursued basic and applied research on the perception and reproduction of sound

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[133]Interview with Frank E. Mullen by George C. Biggar, p. 39, April 16, 1969, OH AT110, Broadcast Pioneers Library, Library of American Broadcasting, College Park, Maryland (hereafter LAB). Mullen took over the Information Department, whose operation "did not meet with Mr. Sarnoff's approval."

[134]RCA Photophone, which developed and marketed sound-on-film technology, was merged with RCA Victor in 1932: Haber, "An Address," p. 13, DSL.

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throughout the Depression. Under the leadership of Harvey Fletcher, acoustics researchers measured the power and frequency range of musical instruments singly and in orchestras; levels of background noise in rooms; the audible frequency ranges for voice, instruments, and noise; and the relative loudness of tones of different intensities.[135] By 1933 these men developed national standards for defining, measuring, and comparing the loudness of different frequencies at different intensities.[136]

Even as RCA Victor's managers, marketers, and engineers struggled to keep the phonograph industry alive for the home consumer, their counterparts at RCA Photophone and Bell Labs extended the

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[135]L. J. Sivian, H. K. Dunn, and S. D. White, "Absolute Amplitudes and Spectra of Certain Musical Instruments and Orchestras," Journal of the Acoustical Society of America (hereafter JASA) II (January 1931): 330-71; W. J. Williams and Ralph G. McCurdy, "A Survey of Room Noise in Telephone Locations," Bell System Technical Journal (hereafter BSTJ) IX (October 1930): 652-67; W. B. Snow, "Audible Frequency Ranges of Music, Speech and Noise," BSTJ X (October 1931): 616-27; Harvey Fletcher and W. A. Munson, "Loudness, Its Definition, Measurement and Calculation," JASA V (October 1933): 82-108.

[136]See Fletcher and Munson, "Loudness," 82-108; P. L. Alger, "Noise Measurement Being Standardized: I--Progress in Noise Measurements," Electrical Engineering 52 (November 1933): 741-44; Harvey Fletcher, "II--Proposed Standards for Noise Measurements," Electrical Engineering 52 (November 1933): 744-46. For an example of an RCA engineer's recognition of the significance of this work, see S. V. Perry, "Loudness Ratio vs. Power Ratio," The Scanner 2, no. 5 (May 1937): 34.

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technical capabilities of sound reproduction systems for commercial users. After licensing Victor and Columbia for electrical recording, AT&T pursued sound recording and reproduction for the motion picture industry through its subsidiaries. While Victor found itself unable to assemble a complete system to exploit the qualities of the longplaying record for the consumer, Bell researchers introduced a vertically cut recording system whose specifications set a standard for broadcast recordings.[137] In theatres, until AT&T withdrew funding for research and development in this field in 1934, the phone company engaged RCA in a contest between the former's "wide-range" and Photophone's "high fidelity" soundtrack systems.[138] By the middle of the decade, Victor's

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[137]See H. A. Frederick and H. C. Harrison, "Vertically Cut Sound Records: Recent Fundamental Advances in Recording and Reproducing Sound Using Vertical Undulations on a Disk," Transactions of the A.I.E.E. 51 (December 1932): 987-92, and idem, "Vertically Cut Sound Records," Electrical Engineering 52 (March 1933): 183-87; Keller, 15-29; and Robert E. McGinn, "Stokowski and the Bell Telephone Laboratories: Collaboration in the Development of High-Fidelity Sound Reproduction," Technology and Culture (January 1983): 38-75. The results of the colloboration may be heard on Early Hi-Fi: Wide Range and Stereo Recordings Made by Bell Telephone Laboatories in the 1930s, Leopold Stokowski Conducting the Philadelphia Orchestra, 1931-32 (Bell Telephone Laboratories sound disk, 1979), and vol. 2 (1980) under the same title. For the business of transcription recordings, see Michael Biel, "The Making and Use of Recordings in Broadcasting before 1936," (Ph.D. diss., Northwestern University, 1977).

[138]Scott Eyman, The Speed of Sound: Hollywood and the Talkie Revolution (Baltimore: 1997), 362. For the competition in motion picture sound systems, see, for example, Sydney Read, Jr., "RCA Victor

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engineers drew on this research as well as their own. They had a better understanding not only what people could and should hear, but they used more sophisticated test and calibrating equipment, more efficient and responsive tubes, amplifiers, and pickups, as well as improved recording and record plating techniques to improve the sound of the phonograph record.[139]

Section XIII: Marketing the Music, 1932-1938

Before RCA Victor's engineers could apply any of this research to the consumer, the marketing staff had to rebuild an audience for records

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High Fidelity Film Recording Equipment," Journal of the Society of Motion Picture Engineers (hereafter JSMPE) 20, no. 5 (May 1933): 396-436; F. L. Hopper, "Wide-Range Recording," JSMPE 22, no. 4 (April 1934): 253-59; also Tom Owen, "Summaries of 15th Annual Meeting Sessions: Early Hi-Fi and Stereo Recording at Bell Labs - 1931/1932," Association for Recorded Sound Collections Bulletin, no. 14 (1981): 30-31. The history of talking pictures has a substantial literature; see Donald Crafton, The Talkies: American Cinema's Transition to Sound, 1926-1931, History of the American Cinema vol. 4, gen. ed. Charles Harpole (New York: 1997), and Douglas Gomery, "The Coming of Sound: Technological Change in the American Film Industry," in Tino Balio, ed., The American Film Industry, rev. ed. (Madison, Wis.: 1985 [1976]), 229-51. Dr. Emily Thompson, University of Pennsylvania, is studying the relationship between sound engineering and notions of modernity. She gave a paper, "Sound, Space, and the Technology of the Talkies," at the Society for the History of Technology Annual Meeting, Towson, Maryland, October 16, 1998.

[139]For examples of the equipment used for acoustic R&D at RCA Victor, see S. V. Perry, "Apparatus and Methods used by the Receiver Division for Routine Loudspeaker Response and Acoustic Measurements," The Scanner 1, no. 12 (December 1936): 10-13, LAB, which has a complete run of this internal RCA Victor publication.

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as entertainment, much less as a venue for better sound. That year, Victor's management acted on Sarnoff's suggestion and the pleas of the public for a cheaper phonograph. Other companies had tried this with less success. Columbia promoted a $55 "Radiograph" in January 1930, a turntable that played back through a radio and, the copy claimed, "puts your Radio in the Five Hundred Dollar class!" The Operadio Manufacturing Company offered an attachment in the spring of 1932.[140] Highlighted in the summer sales campaign, Victor's $49.95 "Radio-Fonograf" helped swell the sales of classical albums to two thousand a set in 1933, up from five hundred a year earlier.[141] In August 1934, under Wallerstein's initiative, the company began selling the R-93 attachment. Priced at $16.50, the "Duo Jr." featured a cheap turntable and a heavy magnetic pickup, but it helped persuade a new generation to add records to their leisure activities.[142]

By mid-decade, the renovation of marketing sound and music at RCA changed. Whereas Wallerstein had fought for change earlier from

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[140]Full-page Columbia advertisement, TMWRMM, January 1930, 18; Gelatt, 252; "Record Playing Attachment," Electronics, April 1932, 144.

[141]"RCA Victor Challenges the Summer Slump," 24-25; Sanjek, 122.

[142]"Editorial," MLG, August 1933, 3; Sanjek, 123, 125; Sutton, 18; Gelatt, 266-67, includes himself among the converts.

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his position within the Record Department, by December 1936 he enjoyed institutional support from the RCA Victor Division Management Group. Of the six men who oversaw the division, H. C. Bonfig directed sales of products while Thomas F. Joyce coordinated their advertising. Victor thus began to sell records, phonographs, and radios as part of a system integrated in the home.[143]

At the same time, the company had begun to impose some structure on the technical end of innovation. Under L. M. Clement, vice-president in charge of research and engineering, the process was broken into research, advanced development, and product design that led to the manufacturing divisions. Advanced Development was the "idea factory" where engineers converted the insights of the Electronic and General Research Departments into prototype products for sale "one or two years" later. They not only had to justify the expense of their work against the Victor's bottom line or patent position, but they worked with the product designers to ready innovations for mass production.[144]

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[143]"Management Groups," The Scanner 1, no. 12 (December 1936): 36.

[144]See the text of talks given by Clement and the Engineering Department heads under "Departmental and Administrative Information: The Engineering Department's Place and Duties in the RCA Manufacturing Company - Victor Division," The Scanner 1, no. 12 (December 1936): 22-35. Quotes are from F. X. Rettenmayer, "Receiver Division" therein, 22-3.

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One of Victor's problems lay in the lack of households with electrically powered phonographs and the lack of outlets from which consumers could buy records. Working closely with the distributors who survived the early 1930s, the company trained dealers in sales and developed the "Music America Loves Best" catalog. This enabled new dealers to start with a minimal investment while they canvassed neighborhoods for new members of the Victor Record Society that Joyce revived. Members paid $14.95 for the attachment, received a monthly magazine, and picked out nine dollars worth of Victor discs.[145]

Victor coordinated dealer promotions with a national multimedia campaign in magazines and newspapers, over NBC's "Magic Key" classical program, and through a nightly radio series for popular records. The division sponsored an "Oldest Victrola Contest" in an attempt to spur trade-ins of acoustic talking machines. In stores, the company provided displays and placards, and began packaging selected Red Seal albums in color-illustrated wrapping. Wallerstein assigned forty percent of the budget to Red Seal records, on the premise that the pricier discs appealed to older prospects willing to buy up to more expensive

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[145]C. B. Larrabee, "1938 Victor Player Sales Beat Whole of 1937; A Striking Depression Victory," Printers' Ink, June 23, 1938, 17-20, 63-64.

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phonographs, and to the middle-class audience seeking the patina of high culture.[146]

Sales continued to rise, player sales in 1938 matching 1937's record total in four months. The book industry took note of Victor's success, one writer arguing that publishers needed a similar program if it was to revive sales.[147] RCA was not alone in reviving the phonograph. Other companies began offering regular ten-inch popular records for thirty-five cents. While RCA Victor promoted its Bluebird line, Columbia acquired the Vocalion label, renamed it Okeh, and assigned pseudonyms to performers in order to protect the value of the company's label. Jack Kapp and E. R. "Ted" Lewis organized Decca Records, a label with no reputation or trademark to protect, to sell popular stars under their own names. Lewis also innovated album packaging beyond what others besides Wallerstein considered seemly. Although Victor sometimes wrapped albums in with colorful illustrations, the albums themselves remained shades of blue, brown, and black. In the fall of 1938, Decca

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[146]Ibid.; "Oldest Victrola Contest Winners Awarded Prizes," Radio-Craft, May 1939, 676, 703.

[147]Frederic L. Melcher, "Editorial: They Built Up Their Outlets," Publisher's Weekly, July 9, 1938, 97.

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began adding color to the covers of the albums themselves, which helped them stand out among a buyer's possessions.[148]

Section XIV: RCA Invests in Innovation, 1935-1937

As the record industry began to revive, Victor did not try to introduce better sound in the home immediately. For two years, the division's management struggled with the "combative spirit which existed . . . between Engineering and Manufacturing, Purchasing and Sales," while it standardized inventories and streamlined processes.[149] Price competition also worked against improving listeners' ears to better sound from their radios or phonographs. To reduce the cost of loudspeakers, for example, Victor's engineers reduced the amount of copper wire contributing to the electromagnet driving the speaker. To compensate for the loss in acoustic output, they increased the power

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[148]C. B. Larrabee, "Record Prices Drop as Columbia Stages Sensational Revival," Printers' Ink, December 20, 1940, 70. For more on album art and design, see Eric Kohler, In the Groove: Vintage Record Graphics, 1940-1960, with an introduction by Tony Bennett (New York: 1999).

[149]See vice president L. M. Clement's comments on "The Engineering Depratment's Place in the RCA Manufacturing Company - Victor Division," and W. P. Short, "Standardization in Engineering," both in The Scanner 1 no. 12 (December 1936), 22 and 34, respectively; Reference Book of Engineering: Supplement to the December issue of The Scanner, December 1938, 17, quote on 21, 35.

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output of the amplifier. This frustrated, any attempt at wide-range sound reproduction without noticeable distortion.[150]

By 1936, however, several factors encouraged another attempt at innovation. First, the economic revival expanded the number of prospective customers. Second, those customers were more than prospects, as evidenced by the boom in classical music albums. Middle-class adults, especially men, had learned to appreciate classical music as something more than an effete pursuit, thanks to radio programming by NBC and the Columbia Broadcasting System (CBS). During the Depression, listening to "serious" or "long-hair" music at home on weekends was the cheapest entertainment available. Moreover, classical music appeared to offer men spiritual solace in a time of cultural doubt.[151]

Whatever the reason for the sales increase, RCA Victor's management budgeted $14,800 in 1935 for advanced research in disc recording and reproducing. Two of the seven projects, "High Fidelity

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[150]Harry F. Olson, "Extending the Range of Acoustic Reproducers," Proceedings of the Radio Club of America 18, no. 1 (January 1941): 1, 3.

[151]Dickson Skinner, "Music Goes Into Mass Production," Harper's Magazine, April 1939, 484-90. Susan Douglas, in Listening In, 150-51, analyzes the increased male interest in music in the 1930s; John Payne of ASCAP supports one of Douglas's sources for a spiritual source to music appreciation in Thomas McMahon, "Record Business," Today, September 26, 1936, 12-13, 25.

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Long-Playing Records" and the "High Fidelity Phonograph," were directed at the home consumer.[152] The marketing department requested of the engineers a phonograph with the widest possible frequency range, given the noise of the 78, and the ability to raise the volume significantly without distortion. In May 1936, Charles M. Sinnett's group produced the $150 R-99, a phonograph offering a frequency response from fifty to seven thousand cps and a dynamic range of sixty decibels. A licensing agreement with the Brush Development Company for the latter's piezo-electric crystal pickup reduced the pressure of the stylus on the record from four to one and a half ounces and a discriminator circuit contributed to these specifications. The R-99 used an unprecedented fifteen watts of power to amplify the movement of the stylus through five tubes and a twelve-inch speaker. This machine, and its more expensive sibling, the D-22, provided a frequency range of 85-7,200 cps,

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[152]"Detailed Budget, Research and Advanced Engineering for the year 1935, R.C.A. Manufacturing Company, Inc.," p. 3, "RCA Labs--Building Activities" file, David Sarnoff Research Center Historical files, courtesy Alice Archer, now in the DSL. The total RCA Victor budget was $499,800, of which television and facsimile research comprised some $180,000 (p. 4), and the "Armstrong Noise Reduction Method" $3,750 (p. 5).

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compared to the 150-5,500 cps provided by the Orthophonic Victrola, and twenty or more decibels than the company's best previous system.[153]

As for the record, the engineers ran into technical and commercial difficulties. To obtain more playing time, engineers considered reducing the diameter of the stylus to one mil, which would have the advantage of improving high-frequency response. But the challenge of mass-producing styli and a lightweight tone-arm made it impractical.[154]

Reducing the speed of the record player presented fewer objections from the customer or manufacturer. Developing a "simple and satisfactory driving system" was important "if disc records are to provide the high order of musical entertainment which they should." Edward W. Kellogg, the engineer in charge of turntables, found a simple method for maintaining constant speed of the platter, but he could not eliminate

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[153]C. M. Sinnett, "Volume Expander Technical Notes," The Scanner 1, no. 1 (January 1936): [1-2]; Sinnett, "Application of the Audio Frequency Discriminator," The Scanner 1, no. 3 (March 1936): 11-12; H. J. Schrader, "Vibration Pickup Type TMV-150-A," The Scanner, 1, no. 3 (March 1936): 12-13; Sinnett, "R-99--High Fidelity Electrola," The Scanner 1, no. 5 (May 1936): 6-7. See also B. L. Aldridge to C. M. Sinnett, November 25, 1955, Hagley 2069, Historian's series III--Museum Files, box 5, folder 14: "Miscellaneous;" "Phonograph R-99 (1936)," Hagley 2069, Historian's series IV--Model Files, box 6, folder 102. Aldridge's frequency ranges vary from those given at the time, despite his consultations with Sinnett.

[154]B. Carson, A. Burt, and H. Reiskind, "A Record Changer and Record of Complementary Design," RCA Review 10 (June 1949): 178.

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the vibration from the motor and linkages to the turntable. For the time being, Victor would not give 33 1/3-rpm "serious consideration" for home use, but "there is always the possibility that future developments may make it desirable to offer long playing records. The two-speed turntable is therefore by no means a dead issue."[155]

The Marketing Department turned these developments into a campaign for "Higher Fidelity" and high culture. In the spring of 1936, Leopold Stokowski and the Philadelphia Orchestra toured twenty-seven cities in North America to promote music sold by Victor.[156] The R-99 and the top-of-the-line D-22 phonographs became the centerpieces of a campaign for "higher fidelity" recordings that "perfectly reproduced" the "living quality of greatness" in Victor's stable of artists.[157] Even the R-93 attachment and acoustic Victrolas were included as Victor sold "Modernization Kits" to servicemen to upgrade phonographs to the

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[155]E. W. Kellogg, "Minimizing Speed Fluctuations in Turntables," TR-340, quotes on 2-3, 10.

[156]"Orchestra on Wheels," Printers' Ink, May 7, 1936, 80; "The Dealer's News-Forum: RCA-Victor to Sponsor Stokowski Tour," American Music Lover (hereafter AML), February 1936, 301.

[157]Quotes from RCA Victor advertisement in The American Mercury, April 1936, xiii.

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better sound.[158] One RCA Victor manager defined "Higher Fidelity" recording as "the most faithful reproduction of actual performance that has yet been developed." "Properly reproduced" on the D-22, "the Victor Higher Fidelity Record of today will give satisfactory reproduction from approximately 30 to 10,000 cycles." He concluded with word that development work in the labs was continuing: "to paraphrase the slogan of a well-known automobile manufacturer, 'When Better Records Are Made, Victor Will Make Them.'"[159]

In the mid-1930s, the marketers at RCA Victor still understood the appeal of extended playing time as part of the limited market for better-sounding phonographs. They directed the Higher Fidelity campaign at the older and affluent adults who could afford the sound that improved in direct correlation with the cost of the equipment. The D-22 represented less than one percent of Victor's radio and phonograph sales.[160] These listeners enjoyed classical music, symphonies, and perhaps musicals. They were far less likely to buy the ten-inch pop

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[158]RCA Victor Service Notes for 1935 (Camden, N.J.: 1935), 20-24, Sarnoff Corporation library, Princeton, N.J..

[159]W. W. Early, "A Brief History of Records," May 1, 1936, Hagley 2069, Historian's series I, box 1, folder 22, "RCA Historical Data: part 3 of 4."

[160]Olson, "Extending the Range," 1.

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music 78 that comprised ninety-eight percent of all sales at the start of the decade.[161]

Section XV: The Consumer Response

Despite the assertions of engineers and marketing management, it was not at all clear that even the affluent responded more to the improvements in sound or to those in convenience and expanded repertoire.[162] Better sound was not a priority and attempting to provide it invariably ran into either the problem of needle scratch or revelation of some previously unknown distortion in the system when the engineers solved an obvious one. Engineers spent at least as much effort

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[161]"RAE-79," Hagley 2069, Historian's series VI, box 10, folder 14: "Sales and Marketing Materials, 1931." See also the percentages of popular music record sales charted against playing time cited in Carson et al.,, "A Record Changer," 183, fig. 7.

[162]For examples of RCA Victor's presentation of its work in engineering, both within RCA Victor and to commercial customers, see Thomas F. Joyce, "A New Era in Sound Motion Pictures," an address before the Motion Picture Theatre Owners Association, The Scanner 1, no. 4 (April 1937): 22; B. R. Carson, K. A. Chittick, D. D. Cole, and S.V. Perry, "New Features in Broadcast Receiver Division," The Scanner 2, no. 6 (June 1937): 27-33; the explanation for the triple-cone loudspeaker in Reference Book of Engineering, 48; "Review of Engineering Progress for the Year 1938: High Fidelity Receivers," The Scanner 4, no. 1 (January 1939): 8.

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on issues of convenience, like improving record changers or needle replacement.[163]

Nonetheless, discerning consumers noticed the change. Eighteen months after Burrill highlighted the problem of quality control, music lovers were still complaining that "fifty percent of all records" were badly centered or punched with oversized spindle holes.[164] By May 1935, when Peter Hugh Reed resurrected the Music Lovers' Guide as the The American Music Lover, no one decried manufacturing practices. A year later Irving Kolodin, reviewing albums in one of the new columns in the general press, noticed the difference even, apparently, without the R-99. In Stokowski's rendition of L'Oiseau de Feu, Kolodin found an "astonishing quality " of reproduction therein, which he attributed to the conductor's "interest in recording."[165] Another critic echoed how Stokowski's latest work superceded his 1928 recording which, when

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[163]See Lewis M. Clement, "Some Problems Encountered in the Development of Features for the 1937-38 RCA Line of Receivers: Phonographs," The Scanner 2, no. 6 (June 1937): 11; D. D. Cole, G. G. Gerlach, and W. P. Short, "The 1939 RCA-Victor Broadcast Receivers," The Scanner 3, no. 6 (June 1938): 12-13; and J. M. Riddle, "Instruments Recently Announced by the Receiver Division," The Scanner 4, no. 6 (June 1939): 4.

[164]John E. Nieland to the editor, MLG, June 1934, 300.

[165]Irving Kolodin, "Recorded Music," reviews of RCA Victor Albums M-294 and M-291, The American Mercury, April 1936, xiii.

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"compared with this new high-fidelity recording . . . now sounds incredibly thin and faded."[166]

More broadly, the mid-1930s saw the first attempt to unite high culture with high technology in a magazine, and a sea change in the commentary on records. Reed announced in his first editorial that AML would portray music in all "its various aspects as reproduced phenomena." He intended to feature pieces by "various technicians" since "reproduced music is irrefutably linked to the scientist."[167]

No engineer appeared in the first two years, but the reviews and letters columns revealed significant changes in the technical interests of critics and readers.[168] Gone were the debates over the best fiber needle and the concern with tone. The reviewers paid attention to the "balance" achieved by microphone placement. They lauded the "high

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[166]P. M. [Phillip Miller], review of Bach's Toccata and Fugue in D Minor, performed by the Philadelphia Orchestra, Victor disc no. 8697, AML, September 1935, 178.

[167]"Editorial," AML, May 1935, 3.

[168]Chester M. Sinnett actually explained recent advances earlier that spring: "The Advancement of Record Reproduction: An Outline of Phonography," MLG, March 1935, 9-10, 14.

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fidelity and dynamic range" of a Eugene Ormandy concert recording.[169] No one harkened back to earlier acoustic or electric recordings.[170] Nor did Reed accept complaints of duplication of the catalogue. He appreciated new renditions for the sake of interpretation and for the "range of nuance and brightness" available to Stokowski and others restrained in the past "by old mechanical deficiencies."[171]

Reed also applauded Columbia's "new 'Wide-range' recording" technique, which gave the listener at home the "brightness of the concert hall. Even on a machine . . . not equipped to reproduce the so-called 'highs,'" Reed could find "qualities of string tone unheard from older recordings."[172] In the lack of a matching machine, Reed referred to the only frustration music lovers felt. The new recordings needed a

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[169]Nor did they complain about the $16.50 cost for eleven discs: P. H. R., review of Gustave Mahler's Symphony No. 2 in C Minor, performed by the Minneapolis Symphony Orchestra, Victor Set no. M256, AML, May 1935, 17.

[170]The lone and qualified exception is Emil V. Benedict, "On Second Thought," AML, September 1935, 168-71, 176.

[171]"Editorial," AML, August 1935, 99.

[172]Columbia may have licensed Bell Labs's sound on film technology for recording: see P. H. R., review of Tansman's Triptyque for String Orchestra, performed by the St. Louis Symphony, Columbia Set no. 213, AML, June 1935, 50.

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"modern machine" or a "strong phonograph" to do them "full justice."[173]

Section XVI: Shaping the Sound from Higher to Lower Fidelity

Despite the enthusiasm and growing sales, there were nagging doubts on the production side. Kellogg, head of Advanced Development for Victor's Sound Engineering Department, confessed his own frustrations in an in-house article entitled "Distortion (Some personal reflections)." He reviewed how each addition to the chain of sound transmission from the telephone onward added another form of distortion to the signal. Tongue only half in cheek, Kellogg took "great satisfaction" in having contributed to "toward the development of loudspeakers which could add grunts and groans and roars to the squeaks and scratches which had hitherto characterized radio reception."[174] Another engineer observed later how the public had

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[173]A. P. D. [A. P. De Weese], review of Hector Berliosz's Les Troyens A Carthage. Inutiles Regrets, sung by Georges Thill, Columbia disc no. 9098M, AML, February 1936, 312; Benedict, "On Second Thought," 171.

[174]E. W. Kellogg, "Distortion (Some personal reflections)," The Scanner 3, no. 9-10 (September-October 1938): 9.

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rejected the RCA console that offered a frequency range up to eight thousand cycles.[175]

If music listeners did not want greater frequency range, what did they want? This became a more pressing question as sales continued to climb, inviting new price competition in the phonograph industry, and as the Federal Communications Committee began accepting applications for radio licenses based on frequency-modulation, which promised far better sound.[176] If high fidelity appealed to the mass audience, RCA would be justified in investing in more phonograph sound research, which would pay off in patent licenses and a means to combat competition on price alone. The company needed to see what the public preferred, and Victor's William Perkins surveyed 236 employees at the Camden plant to find out.[177]

The results did not offer an incentive to improved reception or record innovation. Ninety-four per cent of the non-engineers preferred

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[175]Harry F. Olson, "Subjective Frequency-Response Tests," RCA Laboratories report Z-2, p. 1, Olson Papers, Sarnoff Corporation library, also in Hagley 2069, series XXII, box 143.

[176]Tom Lewis, Empire of the Air: The Men Who Made Radio (New York: 1991), 278.

[177]W. Perkins, "Phonograph Listening Tests," RCA Victor TR-473, December 22, 1939, Hagley 2069, series XXI, box 119.

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limits under 5,000 hz. Perkins also compared a violinist playing live and through a speaker. Listeners agreed that the open-frequency performance was more realistic, but there "was unanimous agreement the limited range electrical reproduction [5,000 hz] was more pleasing than the actual performance."[178]

Perkins's report confirmed what marketers already suspected. Following predictions "at the beginning of the year" for "low cost merchandise" and portable machines, the company offered just that for 1940, including two springwound acoustic Victrolas.[179] By the summer of 1940, internal announcements of the new line of products referred to Perkins's research as justification for offering phonographs "with a very sharp cut-off" frequency response at five thousand cycles. Engineers also gave the public what the company and its predecessor, Victor Talking Machine, had disdained since the end of World War I: more low-frequency response.[180]

Section XVII: High Fidelity at Harvard, 1936-1938

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[178]Ibid., 10, 7-8.

[179]J. M. Riddle, "Instruments Recently Announced," quote on 3, 5.

[180]P. F. G. Holst, "The 1941 Line of Instruments," The Scanner 5, no. 3 (July-September 1940): 3.

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While Victor's engineers struggled with consumer preferences and sources of distortion throughout the phonograph system, physics professor Frederick V. Hunt used Harvard University's tercentennary celebrations in 1936 to justify the purchase of commercial recording equipment. Together with graduate student John A. Pierce, he modified the system to gain an unexpected level of fidelity in the recordings, such that they had to develop a pickup of greater sensitivity and lighter weight than any in existence to reproduce the Vinylite recording without damaging it. Hunt and Pierce set about inventing the pickup with the help of the Cruft Laboratory's elderly machinist; at the same time, they worked out the geometries and physics that affected the reproducing stylus's tracing of the groove.

Over the next two years, they presented papers, tested and demonstrated the pickup, and filed for two basic patents on its performance. The six-gram HP6A reproduced frequencies from thirty to eighteen thousand cps with imperceptible harmonic distortion. Their research confirmed RCA Victor's commitment to lateral recording as inherently superior to the vertical method, and laid out the basis for developing longer playing, slower speed records using a finer groove and smaller stylus. Despite the response by engineers across the industry, no producer licensed the pickup from the pair. They were academics, who

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lacked the capacity or the incentive to change the groove dimensions of 78s and mass-produce the pickup.[181]

Section XVIII: Looking Forward from 1939

By the end of the 1930s, however, the problems of sound quality were of minor importance to an industry enjoying sales totals rivaling those of the best pre-Depression years. RCA Victor officials in the Record and Home Instrument Departments could afford to be pleased with the success of their efforts to revive the phonograph record as a part of middle-class home entertainment.[182] The company's record sales more

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[181]F. V. Hunt and J. A. Pierce, "HP6A: A Radical Departure in Phonograph Pickup Design," Electronics, March 1938, 9-12 [cover story]; idem, "On Distortion in Sound Reproduction from Phonograph Records," IASA X (July 1938), 14-28. For a review of Hunt's career, see John V. Bouyoucos, "Frederick Vinton Hunt," IASA 57, no. 6, pt. 1 (June 1975), 1241; Harry A. Scheck, "F. V. Hunt as Author," IASA 57, no. 6, pt. 1 (June 1975), 1251-4; and Benjamin B. Bauer, "F. V. Hunt and the Disc Recording Arts," IASA 57, no. 6, pt. 1 (June 1975), 1327-31. For Pierce's recollections, see John Alvin Pierce, "The Phonograph's Forgotten Heros," Audio, March 1991, 42-46.

[182]See H. S. Maraniss, "A Dog Has Nine Lives: The Story of the Phonograph," The Annals of American Academy of Political and Social Science 193 (September 1937: Revival of Depressed Industries): 8-13; C. B. Larabee, "1938 Victor Player Sales Beat Whole of 1937; A Striking Depression Victory," Printers' Ink, June 23, 1938, 17-21, 63-64; F. Melcher's editorial on RCA's methods, "They Built Up Their Outlets," Publisher's Weekly 134, July 9, 1938, 97; and "Phonograph Records," Fortune, September 1939, 72-75, 92-102. Maraniss was an RCA Victor executive. For a corrective to the emphasis on RCA Victor's role, see William H. Kenney, Recorded Music in American Life: The Phonograph and Popular Memory, 1890-1945 (New York: 1999), 159-68.

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than tripled from 1932 to 1937, and then quintupled to an all-time high in 1941.[183] Production of record players rocketed from 6,000 in 1934 to 152,000 in 1939.[184]

The most significant trend for the future, however, showed sales of radio-phonograph combinations rising from a one to a ten percent share of radio industry production in the five years before Pearl Harbor. The miniaturization and increased efficiency of tube amplifiers enabled consumers to save space while increasing their entertainment options. Moreover, eighty-three percent of these combinations featured an automatic record changer.[185] In that statistic lay the immediate goad to record innovation and the company's greatest effort to modernize the phonograph.

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[183]"Comparison Records vs Instruments, Units, Victor, RCA, and RCA Victor, 1901-1944," Hagley 2069, Historian's series VI, box 6, folder 46.

[184]"Record Player Production from 1934 to 1942 Incl.," Hagley 2069, Historian's series VI, box 9, folder 45.

[185]"Automatic Record Changers: Prospect of Post-War Industry Production," July 11, 1944, pp. 1-2, Hagley 2069, Historian's series VI, box 9, folder 45.

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Chapter 6: Shaping the Sound of Music: The Origins of the LP and High Fidelity, 1939-1950

Section I: Introduction

Between 1939 and 1950 the phonograph record underwent its greatest changes in design and capability since Eldridge Johnson improved Emile Berliner's disc record at the turn of the century. Engineers at the corporate successor to his company, RCA Victor, and one of his rivals, Columbia, innovated vinyl-based microgrooved records that played 45 or 331/3 rpm, far slower than the 78.26 rpm that had become standard since the electrification of turntable motors.[1] Researchers had been aware of the technology and the techniques necessary to make a quieter, longer-playing, less distorted record since the late 1930s, but it took over ten years for inventors, producers, and consumers to agree on the construction and shape of the new formats.

This chapter explains how engineers and managers at RCA and Columbia observed a presumptive anomaly--the problem of more playing time--and arrived at quite different solutions. The factors influencing their decisions ranged from their understanding of their consumers to the internal politics of their companies, from the state of high fidelity research to business strategy, from the availibility of new techniques and technologies to executive and corporate pride. The result was that

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[1]See Warren Rex Isom, "Before the Fine Groove and Stereo Record and Other Innovations. . .," Journal of the Audio Engineering Society 25, no. 10/11 (October/November 1977), 815.

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consumers accepted two types of records, where before they had bought one, and that the new record offering theoretically less capacity for high fidelity became the standard format for further innovation on behalf of better sound.

If events had proceeded as RCA Victor's engineers and marketers anticipated, there would have been only one format. Their patentable 45-rpm Vinylite disc, 67/8 inches in diameter, was designed to play the vast majority of musical selections on a fast-acting record changer of limited fidelity, in response to market trends and consumer preferences. It would have been incompatible with machines designed for 78s, but RCA's management hoped to use its market power and the self-evident advantages of the new record to persuade the industry and consumers to accept a radical innovation.

The onset of World War II, the revival of Columbia as a major label, changes in RCA's organization, unprecedented expansion of the industry, fear of the appeal of other technologies, a broadening interest in high fidelity for the consumer, and the increased influence of music lovers as critics of the industry delayed innovation and changed the environment in which it would have taken place. Columbia drew on the initiative of its laboratory director, Peter Goldmark, to begin research and development of a record that would play longer classical performances without interruption or significant distortion to the recorded sound. Engineers hired from other companies,

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including RCA, used the fundamental work published by Hunt and Pierce in the 1930s to invent a disc that accomplished that task.

The attention paid to the LP as a "revolution" or a "renaissance" in recorded sound is perhaps deserved more because of its success in the marketplace than for its originality in concept.[2] The last chapter showed how RCA Victor attempted a similar format in the Depression, and Thomas Edison briefly marketed a longplaying record in the late 1920s. RCA's engineers completed work on the microgroove 45 before Goldmark started research on the LP, and between the end of World War II and 1948, producers offered vinyl discs and recording techniques that provided "high fidelity" sound.[3]

Nonetheless, in a period of declining sales, Columbia picked the right time to offer the new format to the market and simultaneously resolved the two presumptive anomalies of surface noise and playing time. Classical music critics, writing now for a broader public, applauded the LP not for its sound quality so much as for its fidelity to the composer's intentions. David

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[2]Goddard Lieberson, "A 33-1/3 Revolution in Recording," SRL, June 26, 1948, 40-41; Gelatt, Chapter 22, "Renaissance at a New Speed," 290ff.

[3]This account revises earlier histories of the phonograph industry. Gelatt, 290-96, and Oliver Read and Walter Welch's From Tin Foil to Stereo: Evolution of the Phonograph, 2nd ed. (Indianapolis: 1976), 333-42, focus on classical recordings and denigrate RCA's innovation. C. A. Schicke's Revolution in Sound: A Biography of the Recording Industry (Boston: 1974), 126-30, is dedicated to Wallerstein and also sees no logic in the 45. Andre Millard follows their lead in America on Record: A History of Recorded Sound (NY: 1995), 257.

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Sarnoff's pride and the need to protect the company's investment and trademarked reputation drove RCA to compete with its record designed for a different purpose. Despite its higher fidelity to the sound, the 45 was criticized as another indication of RCA mid-cult marketing. By 1950, the company accepted the LP with the rest of the industry while it succeeded in selling the 45 for its original purpose. These formats have remained in place as standards for the phonograph record ever since, even as other technologies superceded them in the marketplace.

Section II: The Trouble with Changers at RCA Victor, 1939-1944

In 1939 RCA executives looked back at a renaissance in the phonograph industry, where record and phonograph sales increased at an average annual rate of over twenty percent for four years.[4] This was due in large part to RCA's marketing. Edward Wallerstein in the Records Department and Thomas F. Joyce in Home Instruments had promoted the production of turntables played back through radios and established the

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[4]For industry sales, see Stephen Traiman, "The Record Industry in the United States," Journal of the Audio Engineering Society (hereafter JAES) 25, no. 10/11, 786; and Christopher H. Sterling and Timothy R. Haight, The Mass Media: Aspen Institute Guide to Communication Industry Trends (New York: 1978), Table 650-A, 356. For RCA's sales growth, which was higher than the industry's, see David Giovanonni, "The Phonograph as a Mass Entertainment Medium: Its Development, Adaptation, and Pervasiveness," (M.A. thesis, University of Wisconsin-Madison: 1980), table 15, 201; "Record Player Production from 1934 to 1942 Incl.," Historian's series VI, box 9, folder 45, Accession 2069: RCA/GE/Martin Marietta Collection, Hagley Museum and Library, Wilmington, Delaware (hereafter Hagley 2069); "Comparison Records vs. Instruments, Units, Victor, RCA and RCA Victor, 1901-1944," Historian's series VI, box 6, folder 46, Hagley 2069.

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Victor Record Society to lead consumers to more sophisticated--and expensive--music and phonographs as they aged.[5]

While sales rose to pre-Depression heights, the emphasis on cheap players and the increased competition shrank profit margins. The average price of a console declined from $750 in 1928 to under $100 in 1938, when the cheapest radio-phonograph combination could be had for $49.95. RCA's unit price for phonographs dropped more than fifty percent between 1936 and 1940.[6] Efforts to add value, through better sound or new features, had not given the company the market advantage it desired.

While prices dropped, rising sales of consoles with automatic record changers indicated that consumers liked programming their own

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[5]For Joyce and Wallerstein's work, see "Victor Record Society to Boost Sales," The Scanner 3, no. 4 (April 1938): 19, (Library of American Broadcasting, College Park, Maryland, hereafter LAB); "Enlarged General Record Catalogue Released" and "New RCA Air Show Stars Ace Bandmen,"The Scanner 3, no. 5 (May 1938): 22 and 22-3 respectively; "Phonograph Records," Fortune, September 1939, 94; C. A. Schicke, Revolution in Sound: A Biography of the Recording Industry (Boston: 1974), 96-97.

[6]"Phonograph Records: Recovery in the Musical Reproduction Business," The Index (Liberty National Bank, New York), Autumn 1940, 68; "A Review of RCA Manufacturing Company's Radio Receiver and Phonograph Activities Yearly from 1933 to 1940, Inclusive, in Comparison with Sales by All Licensees," April 2, 1941, Hagley 2069, Historian's series VI, box 9, folder 49.

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selections.[7] This demand arose in response to the ways they heard records played outside the home. Jukeboxes flourished after the end of Prohibition in December 1933. Entrepreneurs like Homer Capehart and David Rockola and their engineers provided machines with more choices and easier selection.[8] By 1939, between 225,000 and 300,000 jukeboxes absorbed thirteen to thirty million records, or up to half of all records sold.[9] At the same time, radio programmers and disc jockeys responded to the jukebox's popularity and the sales listings in Billboard magazine by formatting playlists, as in "Make-Believe Ballroom" and "Your Hit Parade." The syndication of these shows encouraged growing numbers of listeners to reproduce this programming at home.[10]

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[7]"Automatic Record Changers: Prospect of Post-War Industry Production," July 11, 1944, pp. 1-2, Hagley 2069, Historian's series VI, box 9, folder 45.

[8]Oliver Read and Walter L. Welch, From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed. (Indianapolis: 1976), 314-19; for more on David Rockola and the history of the Rockola Manufacturing Company, see William Bunch, Jukebox America: Down Back Streets and Blue Highways in Search of the Country's Greatest Jukebox (New York: 1994), 91-107.

[9]Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, 2d ed. (New York: 1965), 276, for the low estimates; "Phonograph Records: Recovery," 66, 69, for the higher numbers.

[10]My thanks to Dr. Susan Douglas, University of Michigan, for pointing out the link between disc jockeys using playlists and consumers buying more record changers; see Douglas, Listening In: Radio and the American Imagination (New York: 1999), 229, 246.

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This trend had technological and industrial consequences. One observer noted that the rising demand for cheap record changers posed an "opportunity for further improvement in . . . record sales through standardization."[11] The 78, after all, had never been designed for changing or to formal specifications. At the end of the 1930s, engineers at different companies had developed four mechanisms for playing records consecutively, all of which had flaws. One "was the best delaminator of Columbia records ever invented." while another "systematically discriminated against Victor records, cracking them neatly."[12] The weight of 78s on the spindle, and the different thicknesses and edges of the discs broke down the drive and separator mechanisms.[13] The drawbacks helped give changers the worst reputation among RCA Victor products.[14] Therefore, at

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[11]"Phonograph Records: Recovery," 72.

[12]Warren Rex Isom, "Record Materials Part II: Evolution of the Disc Talking Machine," IAES 25, no. 10/11 (October/November 1977), 722; and Edward Tatnall Canby, "The New Recordings: How to Relax," The Saturday Review of Literature (hereafter SRL), August 10, 1946, 29.

[13]B. L. Aldridge to Henry G. Baker, February 11, 1946, Hagley 2069, Historian's series VI, box 4, folder 5; Benjamin Carson, Alexander Burt, and Hillel Reiskind, "A Record Changer and Record of Complementary Design," RCA Review 10, no. 2 (June 1949): 174. See also the comments on changers at the beginning of "Music for the Home," Fortune, October 1946, 156.

[14]"RCA Victor's Overall Automatic Record Changer Activity by Changer Mechanism," October 2, 1945, Historian's series, box 9, folder 45, Hagley 2069. See also Kurt List for record changer problems generally in "The Development of the Record Industry and its Techniques," in Neil F. Harrison, ed., Record Retailing Yearbook (New York: 1949), 8.

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the year-end meetings between the sales and engineering staffs, Joyce challenged engineer Ben Carson to design the perfect, fast-acting machine for the 1939 model year. Carson, who had designed all of the company's changers since Victor's first mechanism in 1927, responded that he would have to change the disc as well.[15]

The prospect of standardizing the phonograph industry to patents on players and records must have been a powerful attraction for RCA's management. Seventy-eights were brittle, heavy, and bulky. Manufacturers took losses on breakage in shipment, and as record sales rose, so too did inventory and the need for storage space by producers, middlemen, and consumers. The new system would eliminate the need to manufacture and

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[15]James W. Murray, "Standardization and RCA," SRL, January 29, 1949, 49; "Case Report on RCA Victor Records," J. Walter Thompson Archives, Account files, box 16, folder: "RCA Account History (records through 1977 [?])," p. 45, John W. Hartman Center for Sales, Advertising, and Marketing History, Rare Book, Manuscript, and Special Collections Library, Duke University (hereafter Hartman Center). I have assumed that Joyce, as head of the Marketing Department for RCA Victor's Home Instruments, and Carson, who had designed every changer since 1927, were the principals involved. This is modelled on the routine followed in the Sound Engineering Division, although ideas could also come from other engineering departments or sources outside the company. See M. C. Batsel, "Sound Engineering Division," The Scanner 4, no. 12 (December 1939): 13-14, and Chart I on 15. This timing would explain the occasional reference in RCA promotional literature in 1949 to eleven years of development for the 45. It is possible that the innovation was initiated by E. N. Deacon, a former radio tube engineer, who became responsible for New Product Market Research and Analysis in January 1938: see "Announcement," The Scanner, 3, no. 2 (February 1938): 30. He was given broad powers to investigate prospects from "a neutral position, reporting to the General Manager or the President." I have found no other references to Deacon in any capacity.

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distribute records sequenced for playback on both manual and automatic players. For RCA Victor and its licensees, fitting a record changer, radio, and the television introduced in the spring of 1939 in a console appropriate for the average living room was not feasible with current technology.[16]

To the engineers dedicated to the processing of sound, the shellac record was an insult. Noise generated by the needle abrading the blend of mineral powders and shellac meant that records still offered no better frequency-range reproduction than in 1925.[17] The Vinylite used without

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[16]Record albums for manual players assumed that the listener turned over each disc before proceeding to the next: A-B-A-B. Albums for automatics assumed the listener turned over the stack of 78s after playing a series of sides: A-A-B-B. For the problem of storage, see "Magic Key commercial March 26, 1939," NBC Papers Central Files, Correspondence, box 71, folder 80: "RCA Manufacturing Company, Victor Division 1939," State Historical Society, Madison, Wisconsin (hereafter NBC Papers); and "Analysis of the Market for Model 'X' Record Changer," March 3, 1944, Hagley 2069, Historian's series VI, box 9, folder 45, p. 1. For the issue of consoles, see "Analysis of the Market for Model 'X'," p. 1; "Proceedings of the Annual Meeting of Stockholders," (Radio Corporation of America: 1944, 1949), 149, in "Minutes and Proceedings: Annual Meetings of Radio Corporation of America Stockholders, 1945-1951," 184, 187-88, in the David Sarnoff Library, Princeton, New Jersey (hereafter DSL). For the the size of pre-war televisions, see Michael Ritchie, Please Stand By: A Prehistory of Television (Woodstock, NY: 1994), 63;

[17]H. Olson, "Subjective Response-Frequency Tests," report Z-2, p. 1, Hagley 2069, series XXII, box 143, also in Harry F. Olson Papers, Sarnoff Corporation library; "Music for the Home," 157-59; W. Rex Isom, "Record Materials Part II," JAES 25, 10/11, 723; "Loudness of Familiar Sounds: music and speech intensities based upon Bell Laboratories' survey," unnumbered page from Radio Today, [1938], in Hagley 2069, box 290, "Historical files: Decibels, Spectrums, etc." This file has since been reorganized in Historian's series II.

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filler in high-fidelity commercial recordings was too expensive for standard 78s, where shellac comprised less than fourteen percent of the material.[18]

Finally, Sarnoff had to justify RCA's standing as a patent monopoly sanctioned by the United States government for quite different purposes. Without dominating the marketplace, RCA had standardized and innovated electronic components since the mid-1920s while dodging criticism and anti-trust action. Sarnoff argued that the industry benefitted more than the company from its policy of patent-based innovation. New patents retained licensees' interest, demonstrated that the corporation was not resting on its monopoly, and maintained the value of a reputation and trademark that elevated sales of RCA's own products above price competition. Unwilling or unable to lead in consumer sales, Sarnoff, his marketers, and his engineers all took pride as well as profit in their position of technical leadership.[19] As the more valuable of its AM radio patents

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[18]Specifically, the percentage was 13.6170: "10" Bluebird and Black Label Compound 10-34," RCA Victor Division Record Department Standardizing Notice, Subject: Disc Records Compound, December 9, 1946, courtesy W. Rex Isom. At five dollars a pound, Vinylite for a four-ounce record amounted to $1.25: J. Davidson, "Petrochemical Survey: An Anecdotal Reminiscence," Chemistry and Industry 19, May 1956, 395. My thanks to Dr. Jeffrey Meikle, University of Texas, Austin, for this citation. RCA Victor's Red Seal classical records retailed for two dollars; material accounted for a fraction of the nineteen cents attributed to manufacturing costs and overhead. Those expenses were less than a penny for a popular disc: "Phonograph Records," Fortune, September 1939, 94.

[19]Sarnoff's philosophy runs throughout his pronouncements on the place of RCA in public and private. Internally, however, he made the importance and utility of monopoly more explicit. Compare the pamphlet

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expired, the company had developed patent collections in FM radio, facsimile, and television, and was beginning to market these systems. Extending RCA's patent control to the record industry on behalf of standardization, when it had the leverage to do so, would benefit everyone concerned.[20]

Thus, management agreed with Carson. In order to protect the patent life of the system components, the project became the only secret consumer technology project in RCA's history. For the next nine years, while Carson's

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of his speech to stockholders on May 7, 1935, "Television," DSL, and the edited selection in David Sarnoff, Looking Ahead: The Papers of David Sarnoff (New York: 1968), 97-99, with his "Memorandum on Television Policy," April 18, 1935, pp. 1, 2, and 5, attached to David Sarnoff to the Board of Directors, Radio Corporation of America, May 8, 1935, folder 360, box 41, Office of the Messrs. Rockefeller: Business Interests, Record Group III 2 c, Rockefeller Family Archives, Rockefeller Archive Center, Valhalla, New York. For the marketing of industrial leadership at RCA Victor, see B. L. Aldridge to Joe [B. Elliott], November 28, 1945, p. 2, Historian's series VI, box 9, folder 45, Hagley 2069, and the advertisements for RCA products in Scientific American, April, October, and December 1949. For RCA's interest in engineering standards, see H. I. Reiskind, "Groove Dimensions of Commercial Records," Engineering Memorandum EM-2409, February 10, 1942, Hagley 2069, series XI, box 48.

[20]For more on Sarnoff's business philosophy and strategies, see Margaret B. W. Graham, RCA and the VideoDisc: The Business of Research (New York: 1986), 40-2, and Robert Sobel, RCA (New York: 1986), 10-11, 92-183, passim, especially 101, 169-70. Neither author acknowledges the the regulatory threat overhanging RCA's sanctioned monopoly of radio communications patents from the 1920s through 1958 as a constant influence on Sarnoff's strategy: see "RCA's Television," Fortune, September 1948, in "RCA: The Years 1930-1978 Reprinted in Selected Articles from Fortune," (New York?: 1979?), 30. It seems likely that Sarnoff justified RCA's monopoly to the government and RCA's long-term investment in television systems to his board of directors as a benefit to the public and a protection against antitrust action, respectively.

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Advanced Development Group drew on staff from other departments and divisions as needed, lab and production space for "Project X" and the "X" record were closed to outsiders.[21]

Carson based his initial design on the intention of continuing to fulfill the slogan, "the music you want when you want it," that Victor Talking Machine Company's marketers had coined to combat broadcast radio in the 1920s. Instead of dispersing the support and changing mechanisms around the perimeter of the turntable, Carson took advantage of the design of the new disc to concentrate the parts to hold and separate the discs inside a larger spindle. The speed of the changer affected the speed of the record. After some experiments at forty and 33 1/3-rpm, Carson's team adopted forty-five rpm in 1943 as reliable for changer operation within two revolutions of the turntable, or five seconds.[22] The stability of the stack would come from smaller, lighter records. The new discs would be made of

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[21]For the name, see The 50-Year Story of RCA Victor Records (NY: 1953), DSL, 29. The secrecy which surrounded this project reveals itself in the fact that RCA did not file for patents on the changer and record until March 1949, and that no engineering memorandums or technical reports refer to it. See Carson's patent no. 2,634,135, applied for March 31, 1949, and col. 7 referring to record applications applied for the same month; and the surviving technical file series and the RCA Camden card catalog now held at the Hagley Museum and Library. Several engineers who worked at Camden in the 1940s have also attested to the isolation of the development group.

[22]Carson et al., "A Record Changer," 174-75; see also the Experimental Test Records file, May 25, 1942-June 23, 1943, BMG Archives, New York City. My thanks to Dr. Michael Biel, Morehead State University, for providing copies of this file.

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pure Vinylite, which would also eliminate surface noise. The record was also thinner than the 78, enabling the use of the expensive manmade plastic.[23]

How long should the new record play? The engineers requested a survey of the records in Victor's "Music America Loves Best" catalog. This included classical pieces divided by the composer, like symphonic movements, and did not include current popular hits.[24] Ten-inch 78s that played for about three minutes comprised most of the industry's production, but classical "Red Seal" performances on twelve-inch discs made up thirty-five percent of Victor's gross sales. Seventy percent of the classical recordings ran under five minutes, as did eighty-two percent of the MALB catalog. When all Victor records were considered by unit sales, the figure rose to ninety-six percent, and Carson assumed that the industry proportion, because of Victor's dominance of the classical market, was even higher. Using a narrower groove and one-mil stylus, Carson's group designed a disc

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[23]Carson et al., "A Record Changer," 175-78. The volatility of shellac prices upset manufacturing cost estimates; for example, the "orange fine" shellac used for records jumped from twenty to thirty-two cents a pound between January 1939 and January 1940. Vinyl copolymers sold in the late 1930s for about fifty cents a pound. See "Plastics Industry," Chemical and Metallurgical Engineering (hereafter CME), January 1937, 97; "Plastics in 1941," CME, February 1941, 99; and the shellac price series in CME for January of each year, 1929-1945.

[24]"Case Report on RCA Victor Records," JWT Archives, p. 2; Carson et al., "A Record Changer," 183-84.

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under seven inches in diameter that could play as long as a a twelve-inch 78, or five minutes and twenty seconds.[25]

Carson's team finished the prototype and showed it to Joyce and Home Instrument's marketing department in March 1944. The group saw immediate advantages in the size of the player and the records beyond those specified five years before. The small size and reduction in parts meant the system combined with a radio could sell at $29.95, or half the price of the equivalent pre-war model. Size also enabled more choices in cabinet styling and installation in consoles. Joyce's group estimated that within a year of production, RCA could manufacture 925,000 changers in various formats, or more than six times the number Victor sold in 1940.[26]

Several issues remained to be negotiated with other parties before this could take place. First, "people would not buy the instrument if they thought they were going to be restricted by the manufacturer . . . to his own recordings." Therefore, "it would be wise to interest Instrument manufacturers as well as Record manufacturers . . . to make it an Industry development rather than a Company development." Victor's Home Instruments also had to gain Victor Records' cooperation in giving the new disc "a quality atmosphere." Already there existed cheap children's records

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[25]Carson et al., "A Record Changer," 183-84.

[26]"Analysis of the Market for Model 'X'" and "RCA Victor's Overall Automatic Record Changer Activity," p. 3, Hagley 2069.

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six to eight inches in diameter pressed in a number of colored plastics. The X record was "small for other reasons. If possible it should look like a more costly product than it is."[27]

Finally, the Instrument Department's engineers opined "that the quality of reproduction . . . is commercially satisfactory." This was true for pop music and "all but a comparatively small part of the rest of the catalog." The engineers added that the process of developing the new record indicated the likelihood of their innovating "a 10" and/or 12" record which would have better quality than anything heretofore available commercially."[28] For the marketers, this meant reserving the possibility "at some later date, for an instrument designed for the possible High Fidelity Record -- with reciprocal provision for playing 'X' type records." In the meantime, the prospect of a postwar rollout, when the industry's phonograph inventory was "near the vanishing point--the industry anxious for something new--the public anticipating something radical--seems particularly opportune."[29]

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[27]"Analysis of the Market for Model 'X'," p. 4.

[28]Ibid.

[29]Ibid., p. 5, 7. Apparently someone at RCA Victor showed a twelve-inch 78 playing twelve minutes on a side to the editors of one magazine in 1945: see [Peter Hugh Reed], "Columbia's Long-Playing Disc: Editorial Notes," The American Record Guide (hereafter ARG), July 1948, 329.

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Section III: The Trouble with Changing Systems, 1942-1945

By the war's end in August 1945, however, the situation had changed. In truth, the assumptions behind the development of the 45 had been crumbling since Carson's proposal. Changes in corporate staff and structure, in competitive technologies, in the record industry, and in what the listener apparently preferred to hear all served to change the context in which Victor's prewar system would be introduced. Most importantly, a culture of high fidelity was emerging from disparate elements among consumers even as the company retained its assumptions about the reasons for innovation.

A. Strategy and Structure at RCA, 1942-1945

During World War II, the structure and management of RCA's manufacturing subdivisions changed radically. Between 1942 and 1947, as RCA's management juggled military contracts and then postwar expansion, Carson's Advanced Development Group moved from Camden, New Jersey, to Indianapolis and back again. During the war the company stopped making all consumer products but one; at the Camden factory, "Everything but records was military. The plant was rearranged time and time again."[30]

In addition, the onset of military contracting resulted in the opening of the RCA Laboratories in Princeton, New Jersey, in 1942. Equidistant from the factories in Camden and Harrison, this independent research facility

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[30]Charles Hobbs to the writer, p. 2, August 12, 1996. Mr. Hobbs began work as an electrical engineer at RCA Victor in Camden, New Jersey, in July 1942.

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took the leading voice for high fidelity away from his allies in the Home Instruments and Broadcast Engineering Departments. Harry F. Olson, head of acoustics research, continued to develop better loudspeakers after the war, but his isolation from the people working in one of the corporate profit centers reduced his influence in maintaining RCA's reputation for sound quality.

With the relocations came organizational changes. At the end of 1943, RCA's board dissolved the RCA Manufacturing Company and Sarnoff hired Frank M. Folsom to run the RCA Victor division established in its place. Folsom, "a natural salesman," arrived from a career in department store marketing and wartime procurement with carte blanche to prepare the company for the anticipated postwar boom in consumer electronics.[31] In particular, if RCA was to reap the benefits of introducing television, its manufacturing branch needed better management than it received during the 1930s.

In one of numerous articles published in RCA Victor's in-house magazine, Folsom likened RCA to "a large family"--if not a department store--which stayed strong "only if each member of that family is also strong,

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[31]"Folsom Heads RCA Victor," Radio Age, January 1944, 22; quote from Sobel, 140-41, also 145. Folsom started as vice-president for RCA Victor in January 1944 and was promoted to executive vice-president in June 1945. Folsom is the subject of two fawning articles: Dickson Hartwell, "The Man Who Sells Takes the Helm," Nation's Business, November 1949, clipping in "Addresses . . .," vol. xxiii (1949), 100-104, DSL, and "The Two-Man Team that Runs RCA," Business Week, November 17, 1951, 112-22.

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self-reliant and . . . self-sufficient."[32] To that end, after Folsom hired a Harvard Business School M.B.A. and management consultants to analyze RCA's administration, he decentralized RCA Victor in 1945, changing it from a functional to a product-based organization. Now, each product line, Records and Home Instruments among them, had separate engineering, production, and sales groups.[33]

This arrangement was necessary when anticipating a growth in the scale of production for the postwar market, but it marked part of the sea change in the operation and culture of RCA. Sarnoff's claim that RCA was a "company of men, not of charts," rang true in the 1930s. With no one directly responsible for the outcome of an innovation, RCA Victor's engineering, manufacturing, and marketing groups had to cooperate to

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[32]Frank Folsom, "RCA Manufacturing Grows," Radio Age 3, no. 2 (October 1944): 12.

[33]John L. Mastran, "How RCA Organization is Planned to Meet Changing Needs," RCA Engineer, February/March 1956, 32-33; Sobel, 145; Frank M. Folsom, "Radio Sets in Production," Radio Age 5, no. 1 (October 1945): 18; Robert W. Wythes, "Victor Talking Machine Company: Cost Accounting, General Accounting, Treasury Dept.," typescript (August 1968), [p. 3], courtesy of Mr. Nicholas F. Pensiero, and since deposited at the Hagley Museum and Library as part of Collection 2138. Mastran was the M.B.A., hired in July 1943. This reorganization follows the pattern explained by Alfred D. Chandler, Jr. in Strategy and Structure: Chapters in the History of American Industrial Enterprise (Cambridge, Mass.: 1962). It should be pointed out however, that this represented a subdivision and that RCA already had a multidivisional structure at the corporate level for its manufacturing, broadcast, communications, educational, and research branches. See the listing, for example on the inside back cover of the "Twenty-Third Annual Report, Radio Corporation of America, Year Ended December 31, 1942," DSL.

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develop new systems like television, facsimile, and the 45. With Folsom's change to a product orientation, developing new products became less important than selling the ones RCA already had.[34] Thus RCA Victor Records' advertising agency, J. Walter Thompson, which won the entire RCA account in 1945, did not find out about the 45 system until 1948.[35]

In addition, Folsom brought in his own people or new managers who had no allegiances to the RCA culture. One manager found that on returning to Camden in 1946, "people who had been superior to me in '43 were either dead or retired or absent, and there was a new group entirely, running things, who had never heard of me."[36] Frank B. Walker, who had succeeded Wallerstein in the Record Department, was promoted sideways in 1944 before MGM hired him to run its new record label.[37]

More importantly for the 45, Folsom's changes eliminated its support within management. Vice-president for advertising and promotion for

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[34]See Graham, 45-46, for another perspective.

[35]"Case Report on RCA Victor Television Sets," Account files, box 16, folder: "RCA Account History (television)," c. 1948, 6-9; and "Case Report on RCA Victor Records," 7-8, 45-46, both in JWT Archives. The agency's ignorance of the 45 is inferred from the lack of references to the agency in the Home Instrument marketing documents in Hagley 2069, and the absence of comment on the system in the Case Report until 1948.

[36]Arthur Van Dyck, interview by Edwin Dunham, November 10, 1965, Oral History Transcript AT-125, p. 30, Broadcast Pioneers Library collection, LAB.

[37]Sanjek, 222; "A Platter for the Lion," Time, February 24, 1947, 95.

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RCA Manufacturing before Folsom arrived, Joyce was reduced to general manager in Home Instruments, reporting to Folsom. He could read the writing on the wall: there would be no place in post-war marketing for the man responsible for pre-war efforts. As World War II ended, Joyce left the company for one of its distributors. Before he left, Joyce presumably tried to persuade his peer in the Record Department of the advantages of the 45 system. James W. Murray ignored it. Because of the restructuring, he had no incentive to coordinate marketing with the phonograph group; because of his affiliation with the new regime, he was uninterested in risking his position by backing his predecessor's innovation.[38]

In addition, Murray was no music lover. He maintained that the utility of records lay in hearing "any portion of a symphony or all of it," an attitude that reflected the company's increased emphasis on the middle-class, middle-brow consumer.[39] The importance of catering to the music lovers who once sustained the record industry declined as sales volume rose. The philistinism that accompanied this trend drove Charles

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[38]"Proceedings of the Annual Meeting of Stockholders," (Radio Corporation of America: May 5, 1942), 14, DSL; obituaries for Thomas F. Joyce, New York Post, New York Times, September 10, 1966, n.p., William F. Hedges Collection, file 137A: "The RCA Story," LAB; Charles Hobbs to the writer, June 29, 1996, p. 3.

[39]J. W. Murray, "'Nipper' Listens In," Radio Age 4, no. 1 (October 1944): 39.

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O'Connell to resign as music director and increasingly redirected the music lovers toward Victor's new competition.[40]

B. The Rise of a Rival: Columbia Records and CBS, 1939-1943

Just as RCA Victor's management began mulling innovation in the winter of 1938-39, Wallerstein left to join the American Record Company. Now owned by William Paley's CBS radio network, American became Columbia Recording Corporation under Wallerstein in May 1939. Why he left is unclear.[41] Wallerstein played a crucial role in restoring the record as an entertainment medium and a vehicle for the diffusion of classical music in the 1930s. Restoring the Columbia label as a viable competitor to Victor offered a new and well-funded challenge. He brought with him the marketing techniques that made RCA Victor successful in the 1930s; RCA Victor's chief record engineer, James Hunter; two marketing associates; and perhaps an awareness of his former employer's intentions with the new phonograph system. Shortly after arriving at Columbia, Wallerstein began signing American symphonies and soloists as well as Benny Goodman and Count Basie. He also ordered that all classical recording dates be recorded in

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[40]Charles O'Connell, The Other Side of the Record (New York, 1947).

[41]Michael Gray, "A History of the Sound of Columbia Records," The Absolute Sound, no. 119 (August/September 1999): 31. Wallerstein is among those who claim he first encouraged Paley to buy the record company and hire him to run it: Edward Wallerstein as told to Ward Botsford, "Creating the LP Record," High Fidelity, April 1976, 57.

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four-minute segments on transcription-quality sixteen-inch lacquer masters.[42]

Columbia's new head faced continued innovation in marketing from RCA Victor. Wallerstein's successor, Frank Walker, began sending out reviews of Victor records to newspapers and magazines; by 1941, seven hundred of the print media carried the free publicity.[43] That summer, Joyce arranged for the New York Post to offer coupons for anonymous classical recordings priced at fifty-nine cents apiece. As with the Victor Record Society, the ads included an offer for a cheap record player. As the campaign spread beyond the metropolis, Wallerstein and Columbia made a similar offer without the players in February 1940. Both labels acquired national sponsors to tie the campaigns to local schools and musical organizations.[44]

To keep Columbia from saturating the market with discounted records, Victor sued through the Publishers Service Company. Columbia withdrew the offer, but Wallerstein retaliated that summer. On August 9,

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[42]Gray, "A History," 31; Michael Hobson, "The Classic Interview: The Birth of the LP," with George Avakian and Howard Scott, The Audiofile, http://www.classicrecs.com/newsletter/newsletter/newsletter.chm?Article=6, visited February 17, 1999; Wallerstein, "Creating the LP," 57.

[43]Frank B. Walker, "Phonograph Comes Back," Radio Age 1, no. 2 (January 1942): 24.

[44]While never made explicit, the circumstantial evidence and contemporary industry gossip linked the two record companies to the promotions: "Battle Over Records," Business Week, February 24, 1940, 50-51.

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Columbia announced cuts of up to fifty percent in the label's classical records and packaged the discs in colorful albums. With a fraction of the business compared to RCA Victor, the company had little to lose in profit, and everything to gain in market share. In the next six months, Columbia's classical sales quintupled, helping double its overall sales.[45]

Victor had little choice but to match the price-cut, which stimulated its sales to their highest levels in seventeen years "with a large share of the increase due to extreme activity in the Red Seal division."[46] Joyce and Walker then cut prices on some Red Seal discs to fifty cents in the fall of 1941 in conjunction with the debut of Ben Carson's $425 "Magic Brain" console-changer.[47] While RCA pursued the high end of the market, Hunter introduced a record material that reduced surface noise by half.[48] This

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[45]Ibid.; "Up, Up Go Sales, When Columbia Drops Drab Dress for Records," Sales Management, December 15, 1940, 20-22; C. B. Larrabee, "Record Prices Drop as Columbia Stages Sensational Revival," Printers' Ink, December 20, 1940, 9-12, 69-70; Keith Hutchison, "Everybody's Business," The Nation, January 4, 1941, 20. See also the ad proofs for Columbia's 1940 magazine advertisements in the D'Arcy Masius Benton & Bowles Archives, box 44, folder: "Columbia Records, 1940-41, 1946," Hartman Center. Standard histories emphasize Wallerstein's price cut without referring to RCA Victor's activities beforehand.

[46]"Record Sales," The Scanner 5, no. 4 (October-December 1940): 20, LAB.

[47]Sanjek, 215-16; "Magic Brain," Radio Age 1, no. 1 (October 1941): 20.

[48]"Case Report on RCA Victor Records," p. 6. Hunter's basic claim was insufficiently novel for the patent office; see United States Court of Customs and Patent Appeals, Patent Appeal No. 5395, In Re James H.

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became a sales tool both in ads to consumers and to classical artists, who left Victor for a company where listeners could hear more of the sound of their performances. Wallerstein also expanded Columbia's pop music roster by hiring producer John Hammond to sign Benny Goodman and Count Basie.[49]

By 1943, Columbia's percentage of number one hits rose from zero two years before to thirty-six, while RCA Victor's share of the overall record sales had dropped by a third to forty-two percent.[50] The label's decline and the changes in RCA and the industry since Pearl Harbor moved Victor management to hire its first full-service advertising agency, J. Walter Thompson, that year.

Hunter--Phonograph Record (October Term, 1947), Office of the Clerk, United States Court of Appeals For The Federal Circuit, Washington, D. C.

[49]Gray, "A History," 31.

[50]Bruce Anderson, Peter Hesbacher, K. Peter Etzkorn, and R. Serge Densioff, "Hit Record Trends, 1940-1977," Journal of Communication 30, no. 2 (Spring 1980): table 1, p. 33; "Phonograph Records," Fortune, September 1939, 100; "Case Report on RCA Victor Records," pp. 5-6, 103; Robert P. Dupin, "The Non-Price Competition in the Phonograph Record Industry at the Manufacturers' Level," (M.B.A. thesis: Wharton School, University of Pennsylvania, 1957), 52, University of Pennsylvania Libraries. RCA Victor's earlier market share is extrapolated from the information in the last three sources. See the Columbia advertisements in the D'Arcy Masius Benton & Bowles Archives, box 44, folder: "Columbia Records 1940 Masterworks, Consumer Magazines," Hartman Center. The reduced surface noise did not offset the label's "reputation for less-than-exceptional sound that dogged it throughout the 78 rpm era": Gray, "A History," 31.

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C. All This and World War, Too: Lower Fidelity and Higher Sales, 1942-1945

RCA Victor lost its dominance as record sales rose, the American Federation of Musicians (AFM) went on strike, and the United States entered World War II. The strike and war forced the major companies to recycle older songs and older records. As a result, and independent labels using non-union talent gained greater entry to the expanding market. The third leading company, Decca Records, signed a year before RCA Victor, signed several of its artists, and increased its market share. Since Victor was the last to settle with the AFM, the independents' supply of new talent and music helped squeeze Victor's control from below while Wallerstein's price cut squeezed Victor's margins at the high end.[51]

The industry's sound quality suffered from cuts in shellac and the wax used to record songs. The latter were made in Germany of a wax composition similar to that used by Edison in the 1890s. Victor stockpiled the material, but other labels began making recordings on aluminum and then glass discs coated with acetate-based lacquers. In Columbia's case, the

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[51]For more on the AFM strike, see James P. Kraft, Stage to Studio: Musicians and the Sound Revolution, 1900-1950 (Baltimore: 1995), chapter 6. J. Walter Thompson's "Case Report on RCA Victor Records," asserts from agency research that Decca never threatened Victor's position, and that Victor's market share
suffered from the independents much more after the war: pp. 5-6, 103. The difference may lie in measurement by records sold versus dollars grossed; Victor benefitted in the latter area by the higher prices on Red Seal classical discs.

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switch proved beneficial to Wallerstein's 33 1/3 classical recordings, but Decca struggled to adapt old techniques to the new material.[52]

As British control of India came under pressure from Germany and Japan in 1941, most of the record industry was well prepared for the onset of rationing.[53] In April 1942 the War Production Board (WPB) ordered the industry to reduce the amount of shellac used by seventy percent, limited record production to 1940 levels, and fixed prices to those applied in December 1941. Until the WPB eased restrictions in April 1944, the industry had to make do with allotments equalling half of its prewar totals. To extend the supply of fresh shellac, companies lobbied against further cuts,

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[52]Read and Welch, 333; Sanjek, 215; Gray, "A History," 31.

[53]Sanjek, 215, states that Victor's "warehouses bulged with imported German wax and shellac from India." Alice K. Kean, "Record Market Opens Door to Higher Production," Domestic Commerce (United States Bureau of Foreign and Domestic Commerce), March 1947, 52, reports industry stockpiling during 1941. Perhaps she was referring only to Victor. Net imports of shellac dipped in 1940 before jumping thirty-five percent in 1941. Victor's unit sales of records jumped nearly fifty percent in 1940 from the year before, and another fifty-eight percent in 1941. See the bar chart in "Shellac and Other Forms of Lac," chart issued July 10, 1942, War Production Board RG 179, box 1737, Policy Documentation File 537.1404: "Shellac - Supply and Requirements Summaries, National Archives at College Park, Maryland (hereafter NACP); and "Comparison: Records vs. Instruments (units), Victor, RCA, and RCA Victor, 1901-1944," Hagley 2069, Historian's series VI, box 9, folder 46.

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limited the repertoire they offered, held record scrapdrives, and encouraged dealers to establish trade-in programs for old records.[54]

The industry also sought alternative materials. One was a thermoplastic resin derived from phenol and decomposed bagasse, or sugar cane waste. RCA Victor used it to help recharge the thermoplasticity of shellac from scrapped discs.[55] This and other replacements like zein, a corn protein, and Vinsol, from pine tree stumps, were cheaper than vinyl and acetate plastics, which were unavailable by 1944 except for military purposes. The scrap and rising demand further diluted the use of fresh shellac and degraded the quality of the discs and their sound. Other factors, like the freeze on radio and phonograph manufacture in March 1942 and the

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[54]"Lac Bug vs. Jitter Bug," Newsweek, April 27, 1942, 59; Read and Welch, 333-34; "Informal Conference of Shellac Subcommittee of Protective and Technical Coatings Industry Advisory Committees," October 30, 1942, Policy Documentation File 537.1405; Walter Woodruff, "Staff Report: Shellac," December 2, 1942 [ten-page draft], p. 3, 10, Policy Documentation File 537.141; "Production Conference of Phonograph Record Manufacturers," February 7, 1944, Policy Documentation File 585.6305M, all in RG 179, NACP.

[55]Repeated heating of shellac condenses water out of its molecular structure, turning it from a thermoplastic to a thermosetting resin: John Delmonte, Plastics in Engineering, 3rd ed. (Cleveland: 1949), 91. For bagasse, see T. R. McElhinney, "Research at Valentine Sugars," The Sugar Journal 10, no. 2 (July 1947): 2-3; Will J. Gibbens, jr., "Bagasse as a Source of Plastics," Gilmore's Lousiana Sugar Manual (1940-41), xiii-xvi. My thanks to Carl J. Martin for providing these articles. Mr. Martin worked at Valentine Sugars Company and its plastics subsidiary, Valite Corporation, before joining RCA Victor Records during the war.

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diversion of skilled factory workers to war-related products, added to the degradation of sound quality in phonograph systems.[56]

When the WPB asked how much better records would be if the major labels received more shellac, the chief engineers from Victor, Columbia, Decca, and Capitol found it impossible to say. Until then, the record industry had little incentive for more scientific methods. Variations in scrap quality, inferior staff and equipment, and local practices prevented engineers from quantifying anything about 78s aside from their basic dimensions. One foreman determined strength by pressing a disc with his finger until it broke. Companies evaluated surface noise by listening tests since no one had found a way to measure it in relation to the type of music in the grooves.[57]

While record quality at home suffered for the duration, soldiers heard some of the future of disc records. To entertain the troops, the army's Special Services division commissioned RCA Victor to record and press "V-Disks." Victor made these twelve-inch 78s of pop, country, r'n'b, and classical music out of pure Vinylite. Without any filler, they generated minimal needle scratch; the limited press runs and care given to military

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[56]Sanjek, 216. For the drawbacks of the shellac substitutes, see Leon S. Kaye, The Production and Properties of Plastics (Scranton, PA: 1947), 175-79.

[57]"Production Conference of Phonograph Record Manufacturers," February 7, 1944, RG 179, Documentation file 585.6305M: "Phonograph Records - Industry Advisory Committee Meetings," NACP.

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products assured listeners of records with no manufacturing defects. The program began with a hundred thousand V-Disks in September 1943, and by war's end Victor and other companies were shipping over 330,000 every month.[58]

D. Deferring Innovation at RCA, 1944-1945

The changes in RCA Victor's management and the prospect of rival technologies for the consumer's ears and eyes contributed to the postponement of the 45. Despite the emphasis on television, Folsom wanted RCA to cover the home entertainment market in its entirety. Only fifteen to eighteen percent of radio owners owned turntables, and a significant part of RCA Victor's $40,000,000 postwar sales goal rested on increasing that percentage. That goal did not rest on innovation. Four months after Victor's marketers pondered the future of Carson's system in March 1944, Ben Aldridge of that group prepared two memos on the postwar phonograph market. In them, Aldridge evaluated the industry trends and the likely competition for phonograph combinations in light of the company's postwar planning. Despite his prediction that eighty-three percent of postwar phonographs would use automatic changers, Aldridge

[58]Sanjek, 219.

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never mentioned the 45 as a counter to the competition's scaling up of production.[59]

The absence of the 45 had something to do with the new master of Victor Records. Aldridge was confident that RCA Victor could put over the system, but only with concerted effort, corporate support, and alliance building. Murray, however, was content with the status quo. Records offered music in "the most convenient and economical way . . . . in such a simple form that a child can make full use of them."[60]

Perhaps Murray based his opinion on the Commercial Research Department's survey of 4,300 consumers in mid-1942 about their use of records in anticipation of filling their postwar needs. In any case, Murray accepted the "perfection of automatic record-changing mechanisms of low-cost within recent years."[61] While Carson devoted his efforts to the changer of the future and to the changer for the elite market between 1939 and Pearl Harbor, other companies' engineers continued to seek solutions to the problem faced by the mass consumer seeking a changer a tenth the price of

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[59]Frank M. Folsom, "Radio Sets in Production," 18; "Radio-Phonograph Combinations: Table Models vs Consoles," folder 49: "Sales Comparisons, 1934-1946" and "Automatic Record Changers: Prospects of Post-War Industry Production," both in Hagley 2069, Historian's series VI, box 9, folder 45.

[60]Murray, "'Nipper' Listens In," 39.

[61]E. W. Butler, "Lower Distribution Costs Sought," Radio Age 1, no. 4 (July 1942): 10-11; quote from Murray, "'Nipper' Listens in," 39.

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the Magic Brain. The problems Carson promised to solve with a new record in 1939 had already been solved, by other companies perhaps, but that was not Murray's concern.

By November 1945, Joyce had left and with him went the 45's last managerial sponsor. Even if he had stayed, the "'X-Changer' situation is considerably more complicated than it was the last time." Aldridge saw three obstacles in marketing the 45. First, the changing mechanism was not going to be as cheap "as had been expected." Second, sales of televisions and conventional combinations threatened to deter consumer purchases of a new record system for at least another year. Third, Aldridge feared a repetition of the format wars between cylinder and disc. Victor won that contest, but it might lose this one against the new media if "several . . . manufacturers decide to plug 'wire' and one, or several, decide to plug 'film' and if we alone support the 'X' Model -- particularly if we do not have a strong, sustained, policy."[62]

Section IV: The Trouble with Records: Other Needs, Other Answers, 1939-1948

The technologies Aldridge referred to received a boost during the war, as did others that offered better sound, more continuity, or both for the discerning listener. At the same time, it enabled improvements in the traditional medium for reproducing music. Equally importantly, the war

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[62]B. L. A. [Benjamin L. Aldridge] to Joe [Joseph B. Elliott], November 28, 1945, Hagley 2069, Historian's series VI, box 9, folder 45.

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raised the consciousness of a whole generation of men to the possibility of high fidelity, and gave them the skills and equipment to develop it. Finally, the war--and Petrillo's strike--sharpened interest in and demand for new classical recordings among music lovers, who took an increasing interest in the sound possible from records. These consumers, along with incipient audiophiles and veteran music lovers, organized sufficiently in the late 1940s to gain the attention of the mass media and the major record labels. Their success in installing high fidelity as a symbol of postwar modernity, where it had barely existed before, redefined the meaning of innovation in the record industry.

Two other technologies for reproducing music emerged from the war considerably stronger technically, commercially, and culturally. Frequency modulated (FM) radio and magnetic recording both benefitted from military research and development as well as rising pre-war publicity. As the war wound down, station operators revived or established FM stations, while manufacturers promoted the benefits of new formats of older media that promised higher mark-ups and profits.

A. FM Radio

The other technology seemed to act as a rival suitor for the ears of music lovers and audiophiles. Along with television, as World War II ended, frequency modulated (FM) radio was being refined for the mass market. Credited to E. H. Armstrong in 1933, FM had inherent advantages

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over amplitude modulated (AM) radio in noise reduction, while its bandwidth allocation in the electromagnetic spectrum freed its transmissions of static and provided sound reproduction over 15,000 cps.[63] Armstrong promoted its noise-free, wide-range transmission of classical music to anyone who would listen.

He found supporters, but not among RCA Victor executives who, after the disappointment of "Higher Fidelity," saw television as much more salable. By the end of the 1930s, Armstrong had persuaded a number of entrepreneurs to establish the "Yankee network" of FM stations in New England and licensed his circuit designs to the General Electric Company. Despite difficulties in innovation of home receivers that rivalled those of RCA's television, FM had enough corporate, technical, and consumer support to call attention to the lessons of history. Either record executives would respond to the improvement in radio sound or they ran the risk of repeating the error of Eldridge Johnson in the 1920s.

Whether or not this was the lesson to draw from the relationship of radio sound and records, RCA's management responded to it over time in a

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[63]Virtually all histories of the development of FM rest on Lawrence Lessing's Man of High Fidelity (New York: 1956), a biography of E. H. Armstrong sponsored by the Armstrong Foundation. Gary Frost, University of North Carolina, Chapel Hill, presented a paper, "Corporate Culture and High Fidelity: RCA and FM Radio, 1930-1940," at the Society for the History of Technology meeting, Detroit, October 9, 1999, in which he documented RCA's experimentation with FM transmissions in 1931 and of Armstrong's relationships with the RCA engineers. Mr. Frost is preparing this paper for publication in a future issue of Technology and History.

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variety of ways. One appeared to be Perkins's listener preference survey: would the mass market buy into wider frequency sound? Another was further investment in developing RCA's patent position in FM broadcast technology. RCA Victor announced plans to market the system after the war early in 1944.[64] By then RCA's George Beers had invented a circuit that reduced significantly the cost and effectiveness of FM receivers, and Stuart W. Seeley added another one in 1945. As the corporation's symbol of technological progress, RCA Laboratories endorsed the system because the expanded frequency range represented "high fidelity."[65]

Third was the application of FM to phonograph systems themselves. It was "essential that the . . . sound from records be at least comparable to or preferably better than that . . . from radio" if the record industry wanted to sustain its success. Charles Sinnett and other engineers developed and promoted a system using an FM-based pickup and circuitry at four engineering meetings in the middle of 1942. The system provided a frequency range of ten to twelve thousand hz "with an astonishing freedom from surface noise, mechanical noise, and distortion." The pickup weighed eighteen grams compared the standard seventy grams of a conventional pickup. Finally, unlike the Rochelle salt crystals used in most electric

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[64]"RCA Outlines FM Policies," Radio Age 3, no. 3 (April 1944): 23-24.

[65]RCA Laboratories, "FM Broadcasting," c. February-March 1944, DSL; "New Circuit Lowers Cost of FM Radios," Radio Age 5, no. 1 (October 1945): 23.

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phonographs, it was not subject to damage by heat, humidity, or changes in line voltage.[66]

Other members of RCA were less enthused about the promise of FM as a radio format. The corporation's relationship with Armstrong degenerated into a protracted legal battle over the inventor's basic patents. Ever sensitive to antitrust accusations, David Sarnoff and RCA had to balance the company's standing as a government-founded patent pool; the company's reputation for exploiting lone inventors; and the company's image as the pioneer of innovative systems using the electronic art, as Sarnoff called it. In this case, Sarnoff and RCA's broadcast network, the National Broadcasting Company (NBC), saw pure FM radio as less promising financially than either home facsimile or television. FM competed with these systems for spectrum allocation and the capital budgets of broadcasters as well as consumers. As with the promise of "higher fidelity" records in the 1930s, the acclaim for the wide frequency range of the

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[66]G. L. Beers and C. M. Sinnett, "Some Recent Developments in Record Reproducing Systems," Proceedings of the I. R. E. (hereafter PIRE) 31, no. 4 (April 1943): 138-46, quotes on 138, 145; Nathaniel Rhita, "An FM Phono Pickup," Radio-Craft, November 1945, 106. Olson abandoned the "rather complicated and expensive" FM pickup for a diode electronic pickup, which had its own R&D challenges: quote from "Electronic Phonograph Pickup," p. 1, December 8, 1944, Harry F. Olson Papers, folder: "Pickup--Electronic, 1944-47," Sarnoff Corporation Library, Princeton, New Jersey (heresafter Olson Papers). See also Olson, "Mechano-Electric Transducers," Journal of the Acoustical Society of America (hereafter JASA) 19, no. 2 (March 1947): 307-19.

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system did not translate into a mass market. FM stations would never gain "large audiences" unless they "offered programs attractive to listeners."[67]

For the networks and most radio station owners, this meant broadcasting their AM content on their FM outlets. Some individuals acquired FM licenses in larger cities to play classical or instrumental background music, but few listeners found a more expensive receiver worth what one could already hear on AM. Other consumers bought tuners that turned out to "too cheap to be good," whose performance did not measure up to the promise. In addition, when the FCC changed the spectrum allocation for FM in 1945, 350,000 to 500,000 listeners with pre-war receivers had to buy new equipment.[68] FM radio remained a marginal medium for sound reproduction, but the existence of stations and small networks provided a node around which music lovers and audiophiles could gather.

B. Magnetic Recording

Magnetic tape or wire appeared to solve two problems that had plagued the phonograph since its invention. This was the technology that

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[67]Quotes from "RCA Outlines FM Policies," 23-4; O. B. Hanson, "Down to Earth on 'High Fidelity'," Radio, October 1944; McMurdo Silver, "High Fidelity," Radio-Craft, March 1945, 380-81.

[68]Douglas, Listening In, 262-63; see John M. Conly, "They Shall Have Music: FM to the Rescue!" Atlantic Monthly, January 1951, 91-95, for a detailed review of the postwar growth in FM stations, and Conly, "They Shall Have Music: Tuners, Aerials, and FM," Atlantic Monthly, September 1955, 94. Douglas cites Lessing for the pre-war total of 500,000 FM receivers; RCA estimated that there were 350,000-500,000: "FM Broadcasting," 37.

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accomplished two tasks with equal facility--it could record and reproduce with no significant degeneration of the medium. Furthermore, wire or tape appeared to offer a more durable version of the waxed paper on which Edison had first tested the concept of phonography. They appeared to be an opening to continuous play of any length. Magnetic recording had been widely discussed before World War II, when the economics, if not the quality of the technology, appeared to indicate that magnetic recording and frequency-modulated radio were the media of the future.[69]

The military's need for durable recording media with those qualities stimulated development of magnetic recording and reproduction of sound. One researcher at RCA Laboratories worked on magnetic disc recording. The Armour Research Foundation provided a wire recorder capable of holding five hours of recordings on a spool of wire. General Electric sold portable wire recorders that were so popular with the military and reporters that it received over one hundred applications for postwar licenses. Other inventors demonstrated embossing techniques that offered hours of recording.[70]

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[69]See, for example, the comments on the future in "Phonograph Records: Recovery in the Music Business," 71-72, which ignores magnetic media in favor of photoelectric cells reading film and phonograph pickups.

[70]See J. Guy Woodward's RCA Laboratories notebook no. 25 for the fall of 1943, new file case #1-5, Sarnoff Corporation, Princeton; Sanjek, 221; John T. Mullin, "Magnetic Recording for Original Recordings," IAES 25, no. 10/11 (October/November 1977), 698; and for the most thorough treatment, Mark Henry Clark, "The Magnetic Recording Industry, 1878-1960: An

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After the war, however, manufacturers faced the transition from the military to the mass market. Wire and tape media were inconvenient to use because the consumer had to thread them through recording and reproducing heads and onto the take-up reel. Starting and stopping the reels always threatened to snap the wire, which frequently tangled. These structural drawbacks, together with the overestimation of the appeal of home recording, limited diffusion of magnetic media into the home.

Nonetheless, the Brush Company among other companies offered magnetic wire systems with what one observer described as "excellent fidelity." This assertion was based less on the frequency range--up to 5,000 cps at best--than the reduced distortion within that range compared to phonographs. These played from 15 to 180 minutes on reels costing from $2.50 to $8.25 an hour, which was comparable with the costs of 78s playing the same time. RCA Victor licensed Brush's technology and developed a thirty-minute wire cartridge played in a twenty-five pound machine.[71]

Several factors kept magnetic media from more than a tiny fraction of American homes until the 1960s. Beyond the complexity of these

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International Study in Business and Technological History," (Ph.D. diss., University of Delaware, 1992), especially Chapters 6 and 7 on the work at the Brush Development Company and the Armour Research Foundation, respectively.

[71]"Magnetic Recorders," Radio-Craft, July 1948, 35, based on James E. Jump, SRL, June, 1948; "Recording Sound on Wire," Radio Age 7 no. 2 (January 1948): 18, 31; "Magnetic Tape Recording," Fortune, January 1951, 97-106; Clark, "The Magnetic Recording Industry," 134.

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systems,most players weighed forty to fifty pounds and cost about ten times more than most turntables: $229 to $795. For Victor in particular, the potential of a format war with the 78 seemed to inhibit marketing. One editor observed that the industry, if it improved home recording to a point competitive with the phonograph record, would offer a unique instance of an industry that, "like the scorpion, stung itself with its own tail."[72]

Section V: Shaping the Status Quo: Record Consumption and Production, 1939-1947

Even as anticipation rose and faded over new formats, three factors contributed to the entrenchment of the 78-rpm record as the standard medium. Industry sales seemed to take even the industry by surprise. Manufacturers began to standardize the disc while developments in recording, materials, and playback equipment improved the quality of sound on disc. These changes helped deter RCA Victor's marketers from attempting to introduce the 45 even as they spurred the Record Division and RCA Laboratories to embark on methods of further reducing costs and improving the sound of 78s.

With the relaxation of controls on materials and production of records in 1944 and 1945, sales, prices, and profits began to take up where they left off before the war. Shellac prices shot from thirty-six to eighty cents

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[72]"Magnetic Recorders;" Sanjek, 226; "Editorial: Scorpion," Radio, April 1943, 13. I have seen no reference to RCA Victor's wire recorder beyond the announcement in Radio Age, n. 67 above.

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per pound in 1946-47 before returning to pre-war prices.[73] Consumer sales jumped sixty-five percent in 1945 and doubled in 1946 before peaking at $224,000,000 in 1947.[74] RCA Victor's sales more than doubled in 1946, from $16,000,000 to $38,000,000, a figure matched the following year. At the end of 1946, RCA Victor turned a War Assets Authority factory in Canonsburg, Pennsylvania, into its fourth record plant.[75]

The increase had four consequences. First, much of the sales expansion came from new independent labels, whose share of the market grew from eight to twenty-eight percent between 1944 and 1947.[76] Second, it

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[73]See Folsom's summary of RCA Victor's struggles in "Proceedings of the Annual Meeting of Shareholders," (1946), 72-73, DSL. The WPB fixed the price of shellac at thirty-six cents per pound for the duration. Although the price had more than doubled without adjustment for inflation, demand for vinyl copolymers tripled supply in 1946, even as producers struggled to produce enough plasticizers. See shellac price series in January issues of CME, 1941-1946; F. H. Carman, "Plastic Materials: Review of Supply Outlook," CME, October 1946, 158-59. Kean, "Record Market," 54, states a high of seventy-three cents a pound.

[74]Traiman, "The Record Industry," 786. These figures are based on estimates made by the Recording Industry Association of America, which was not organized until 1951.

[75]"New Record Plant at Canonsburg, Pa.," Radio Age 6, no. 2 (January 1947): 19.

[76]"Case Report on RCA Victor Records," JWT Archives, 29, 41, 103 (Exhibit F). J. Walter Thompson's figures are drawn from Victor on the one hand and a special survey of consumers commissioned by the agency to analyze market preferences. Neither of these mesh with those given by the RIAA in the preceding note, and they conflict with each other on Victor's share of the market. In addition, JWT's numbers indicate that Victor's sales rose only a million dollars in 1946 from the 1945 total of $15,000,000. For an

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stimulated the rationalization of an industry still encased to a large degree by its nineteenth-century origins. Third, the explosion in sales also reduced RCA Victor's relative influence even as it moved the label to increase production and reduce costs. Finally, the success with the status quo reduced the incentive to innovate for the mass market.

In January 1946, as record sales continued to soar and, with them, the demand for record changers, the Radio Manufacturers Association offered a group of standards for consideration by its members. Number 169, "Proposed Dimensional Characteristics of Phonograph Records for Home Use," contained standards for thickness, diameter, stopping groove, and shape of the outer edge.[77] Given the variety of discs on the market and in consumers' collections, the standards did not resolve all of the issues surrounding 78s and changers. As time passed, however, it reduced the incentive to discard the 78 in favor of one company's innovation.

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example of the origins of the independents, see "Smaller Record Firms Spin to Success," Business Week, September 7, 1957, 54. Charlie Gillett, in The Sound of the City, rev. ed. (New York: 1983), surveys the growth of the rock-oriented independents, which also included folk, jazz, classical, and children's labels.

[77]"Proposed Standards of the Radio Manufacturers Association," PIRE 34, no. 4 (April 1946): 200W. Presumably for political reasons, the RMA favored the eccentric stopping groove initiated by Eldridge Johnson and maintained by RCA Victor, but those stamping records with a semicircular or a V-shaped edge could keep their preferences within certain bounds. This became the basis for increasingly international standardization in the record industry: see J. A. Caffiaux, "A Brief Review of EIA Standards in the Audio Field," JAES 16, no. 1 (January 1968): 212-5.

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On the other hand, the sound of the 78 became ever more fragmented because of the variety of recording standards and pickup technologies. The increase in new recording companies aggravated the variety in recording equalization. To limit overcutting of grooves of low frequency and high amplitude, recording engineers set a limit on amplitude up to a frequency between 250 and 800 cps. They also boosted higher frequencies that would otherwise fade or be lost in surface noise as the stylus approached the center of the record. In playback, an amplifier contained a circuit that compensated for the changing emphasis by boosting the low-end and compressing the highs, thereby eliminating much of the noise. Because record companies tailored their characteristic to what they regarded as the best phonograph, and because phonograph makers tried to build circuits that worked well with all records, there was considerable variation in the sound from a record, depending on which phonograph it played back. Even as engineers organized in the late 1940s to develop a single recording characteristic, by 1952, listeners contended with up to eight characteristics on their records.[78]

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[78]R. C. Moyer, "Standard Disc Recording Characteristic," RCA Engineer, October-November 1957, 12, reprinted in Roys, ed., "Record Engineering," 10-11. The story of the development of a general recording standard is described in the articles and announcements concerning the development of the "Sapphire Group" and then the Audio Engineering Society in Audio Engineering between 1947 and 1951. Susan Schmidt Horning, Case Western Reserve University, is writing her dissertation on the evolution of sound recording studios and will cover this subject in

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The playback industry also had to contend with dramatic changes in record pickups and styli. Since the advent of electrical reproduction, engineers had searched for ways to reduce the weight and wear of the steel needle. In the 1930s, Rochelle salt crystals made excellent transducers and reduced the weight of the pickup to two ounces. The reduced pressure encouraged the use of longer wearing osmium compounds for styli before World War II and then replaceable artificial sapphires afterward. The crystals suffered from humidity, however, and their output favored low frequencies. Continued research on electromagnetic transducers led to William S. Bachman's invention of the variable reluctance pickup in 1945. This device tracked the groove at twenty grams and reproduced frequencies out to 10,000 cps. At $6.95, GE's pickup helped build the market for high fidelity in tandem with new record materials and recording techniques. On the other hand, magnetically based pickups generated a thousand times less output voltage than the crystal format. Those listeners who desired the smoother and wider response had to to invest in a new phonograph or modify their old one at considerable expense and with variable results.[79]

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[79]"Your Victrola's jewel-point pickup floats like a feather on water," advertisement on back cover of Radio Age, July 1946; I. Queen, "Postwar Features of Phonograph Pickups," Radio-Craft, September 1947, 36-37, 55; "On Pickups," ARG, December 1947, 97; Richard H. Dorf, "Checking Performance of Phono Pickups," Radio-Craft, August 1948, 33-34; I. Queen, "New Magnetic Pickups," Radio-Electronics, October 1948, 55; "Modern Crystal Phono Pickups," Radio-Electronics, 29; for the accented bass response

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After the war, then, record manufacturers faced a market owning phonographs, pickups, and styli of varying reproduction characteristics, pressures and wearability. The notion of high fidelity for the masses, had they desired it, must have seemed very distant indeed.

As for production efficiency, Victor had started this process in the late 1930s boom when its engineers began automating the pressing and timing processes.[80] Beginning in October 1946, RCA Victor dedicated the 6000 series of engineering memorandums to research in plating, stampers, record materials, production, and shipping. Despite the search for savings, the engineers never sacrificed the company's reputation for quality. Victor records were superior to their competitors, including Columbia's laminated discs, in resistance to breakage, warpage, and wear as well as in dimensional consistency and dynamic range.[81] Folsom echoed their commitment, for

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of the crystal pickup, see [Peter Hugh Reed], "Editorial Notes," ARG, December 1948, 98. Gernsback changed the magazine's name in October 1948. For a thoroughly documented survey of pickup technologies, see B. [Benjamin] B. Bauer, "The High-Fidelity Phonograph Transducer," JAES 25, no. 10/11 (October/November 1977), 732-39.

[80]L. C. Harlow, "Mechanization of Record Pressing," in Record Engineering at RCA (Indianapolis: c. 1957), 18-19. This booklet is a compilation of articles from RCA Engineer published in 1955 and 1956. Copy in the writer's possession, courtesy of Carl Martin.

[81]L. G. Harlow, "Even Thickness Records," Engineering Memorandum EM-6000, October 14, 1946; L. A. Wood, "Physical Tests on Competitive Ten Inch Records," EM-6009, September 23, 1958, both in Hagley 2069, series XIII: "Indianapolis engineering memoranda."

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"quality and value" were "the cornerstones upon which brand name products firmly rest."[82] To sell the increased volume, Victor's market research group began testing self-service sales of records as early as 1942 in anticipation of "record super-markets" after the war.[83]

The reputation for record quality extended to the material comprising the records themselves. The search for shellac substitutes during the war resulted in more experimentation and refinement afterward. The irregularity of shellac as a raw material, in price and composition, did not lend itself to the success of an automated mass-production industry. Engineers and chemists working under Hillel I. Reiskind developed combinations of plastics, extenders, and fillers that matched the qualities of shellac-based records in production and consumption. By 1948, they had completely replaced shellac with ethyl cellulose and Formvar vinyl acetate compounds at the Indianapolis plant.[84]

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[82]Frank M. Folsom, "Brand Names are Trusted," Radio Age 8, no. 3 (April 1948): 22. The EMs in the 6000 series are littered with comments on the need to maintain quality in the search for cheaper materials and processes.

[83]E. W. Butler, "Lower Distribution Costs Sought," Radio Age 2, no. 4 (July 1942): 11.

[84]Harlow, "Even Thickness Records," EM-6000, p. 4; Leon Parker, "Vinylite (VYHH) Potentialities as a Record Material," EM-6010, August 16, 1948, p. 4, in Hagley 2069, series XIII.

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For Victor, competitive pressures at the pop end of the business served as an incentive to improve record quality. The movement into the business by Hollywood-based labels chipped away at Victor and Columbia's pop music market. The low barriers to entry, the competition for the next pop star, and the likely pressure on prices once the post-war boom eased "led to the widespread belief that to remain in business a manufacturer must produce a record of high quality [or] offer appealing innovations."[85] Thus Reiskind drew on the experience of producing V-Discs to produce a better-sounding 78. On August 30, 1945, RCA Victor announced its "De Luxe" Vinylite twelve-inch Red Seal record. Made of a proprietary blend of polyvinyl chloride/acetate copolymer and dyed a translucent red to identify the record itself with the trademark label, Serge Koussevitsky and the Boston Symphony Orchestra's rendition of "Till Eulenspiegel's Merry Pranks" retailed for $3.50.[86]

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[85]Kean, "Record Market," 55.

[86]"Record for the Ages," Newsweek, September 3, 1945, 72; "Unbreakable Records," Radio Age 5, no. 1 (October 1945): 22; F. B. Stanley, "Vinyl Records," Modern Plastics, June 1948, 125-28. Reiskind received an RCA Victor Award of Merit for his vinyl composition: "1946 RCA Victor Award of Merit," Hagley 2069, Historian's series VI or VII?, box 2, folder 8. The association of red surfaces with classical music continued. Vox rerecorded a black plastic pressing of Mozart's Eine Kleine Nachtmusik, on red plastic: "Recent Recordings," Audio Engineering, April 1948, 42; and the Concert Hall Society moved from red Vinylite 78s to LPs: "New Long-Playing Discs, ARG, June 1949, 319-20.

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Some reviewers praised the discs for their low surface noise and "brilliancy" in sound.[87] Music lovers groused about the price, which was attributable to other factors beside the cost of the plastic. Vinyl compounds proved sensitive to the temperatures involved in pressing shellac records, resulting in more rejects in a press run. Second, the reduction in surface noise exposed flaws in the stampers; with tics and pops more apparent, engineers also rejected more stampers.[88] For these reasons, Victor released only three Vinylite albums in the first six months of the program. By 1947, however, as the factory crews mastered the production skills, the price dropped to two dollars a disc and the vinylite record business grossed RCA Victor a million dollars a year.[89]

Despite the transition from natural to manmade plastics, engineers had not solved the primary complaint about sound quality for the mass consumer. Records continued to contain fillers that had generated needle

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[87]"The Record Year," Newsweek, December 24, 1945, 102-104, quote on 104; "Wear of Phonograph Records," Consumers' Research Bulletin, May 1947, 30; Read and Welch, 339, date the discs' debut as October 1946; Sanjek, 226.

[88]Leon Parker, "Low Noise Formvar-Vinyl Acetate Record Compositions," EM-6007, July 5, 1948, p. 4-5; idem, "Vinylite (VYHH) Potentialities as a Record Material," EM-6010, August 16, 1948, p. 4, both in Hagley 2069, series XIII.

[89]Edward Tatnall Canby, "The New Recordings," SRL, April 13, 1946, 92; H. F. Olson, "Preliminary Program Phonograph Record Research," (witnessed May 3, 1948), p. 5, in Herbert Belar's RCA Laboratories notebook P-4613, Sarnoff Corporation Library.

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"scratch" since the turn of the century. The use of mineral fillers continued for several reasons. Without the filler, the records would wear out much more quickly. Many consumers still used phonographs from the 1930s or earlier whose stylus pressure was measured in ounces rather than grams.[90] In production, fillers were far cheaper than manmade or natural plastics, and the postwar inflation encouraged their retention.[91] By 1948, finer fillers were available at no significant increase in cost, but they proved difficult to integrate with the plastics and with contemporary production processes. Moreover, the six- to nine-decibel improvement in surface noise was barely detectable and did not justify further research.[92]

Section VI: Shaping the Sound of Music: The Emergence of High Fidelity, 1939-1947

RCA Victor struggled to balance increased production and quality with the diverse needs of its market within two greater trends. One was the growth of production; the other was the development of a consumer

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[90]The writer's mother recalls obtaining a second-hand, windup Victrola with her roommates for their senior year at St. Agnes School in Alexandria, Virginia, in the fall of 1947.

[91]The search for substitutes extended at least until 1950: G. P. Humfeld, "Production Run on Zein Record Compound," EM-6008, March 14, 1950, Hagley 2069, series XIII.

[92]R. K. Lashof, "Particle Size of Fillers," EM-6004, January 10, 1948, pp. 9-11; E. B. Blay, "The Use of Ethyl Cellulose in Low Noise Solid Records," EM-6005, March 12, 1948; Parker, "Low Noise Formvar-Vinyl Acetate," p. 3, all in Hagley 2069, series XIII.

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interest in better sound. The expansion of "high fidelity" technology, an industry to produce it, and an audience to appreciate it took place in large part as a consequence of World War II. Government funding of research on electroacoustics, production of precision components, and training of technicians provided the basis for a postwar boom in the field of sound recording and reproduction.

Defining high fidelity was and is a tricky proposition. As an experience, it represented an interface between the technical, the sensory, and the artistic. Since the 1920s, scientists and engineers had been tracking down the distortions and noises added to a sound signal in its recording and reproduction. When that signal was musical in nature and evaluated by the ears of a lay audience, however, the distinctions between flaws in the performance, the reproduction, and the perception became exceedingly fuzzy.

Finally, not all of the potential sponsors of better sound were convinced that the mass market preferred high fidelity. Repeated listening tests, reflecting the interests of the sponsors, indicated that most people preferred limited frequency range reproduction. Corporations did not speak with one voice on the issue, however. As it reorganized and diversified, RCA left open opportunities for engineers to develop and promote high fidelity.

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The interest in higher fidelity existed well before World War II. In the radio industry, producers with investments in AM broadcasting touted their commitment to better sound in the face of increasing by prospective competitors in Armstrong's FM format and its superior sound qualities. CBS touted its preparations for high-fidelity AM broadcasting, while the National Association of Broadcasters and the Radio Manufacturers Association sponsored a radio program that demonstrated the extension of broadcast frequency range from 1922 to 1939.[93]

The competition for the listener's ear also came from the phonograph industry, to which Hugo Gernsback's Radio-Craft, "Radio's Greatest Magazine," began to pay more attention. Writers and advertisers encouraged radio servicemen to expand their business by modernizing old phonographs or selling new disc recorders.[94] The magazine's contributors broke new ground in discussions on sound distortion, although not all of this was complimentary. One writer argued that magnetic pickups were "one of the worst offenders" in generating harmonic distortion. Another

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[93]James D. Parker, "High-Fidelity Broadcasting," Radio-Craft, August 1939, 73, 107-109. Parker was a CBS engineer. For the promotion of FM, see "At Long Last--Static-Free Radio!" Radio-Craft, April 1939, 588, 618-19, and Hugo Gernsback's editorials, "Whither Radio?" and "'Static-Less' Radio," Radio-Craft, August and December 1939. Gary Frost, University of North Carolina, Chapel Hill, believes that Armstrong wrote the article.

[94]Harry Paro, "Modernize Old Phonographs!" Radio-Craft, August 1939, 89, 108-109; advertisement for RCA Victor recorder in Radio-Craft, August and September 1939, 107 and 131, respectively.

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was among the first to explain the differences between the effects of harmonic and intermodulation distortion on increased frequency-range reproduction.[95] By 1941, interest in sound reproduction led Gernsback to categorize articles on the subject under "Sound" and to provide a monthly advice column on installations and equipment.

The challenge lay in extending this interest beyond the interest in public address systems or home recording, neither of which necessarily offered better sound than contemporary phonographs.[96] Much of the problem resided in the cost of better sound. In November 1940, Harry Olson, head of RCA's acoustic research group, explained the technical and economic challenges of high fidelity radio receivers. There was an inescapable correlation between higher prices and higher fidelity on the one hand, and declining sales volume on the other. Consoles costing over one hundred dollars comprised eight percent of the market; RCA's top models represented "only a fraction of a percent of total sales." Higher fidelity was

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[95]Quote from S. Ruttenberg, "Fidelity vs. Harmonics," Radio-Craft, May 1937, 664; A. C. Shaney, "Intermodulation--And it Relation to Distortion," Radio-Craft, May 1939, 652-53, 689.

[96]See Leo Fenway, "Sound is the Spur," Radio-Craft, June 1941, 738-39, to see how two radio servicemen in New York City branched into sound installations without reference to high fidelity, and articles on home recording in Radio-Craft, 1940-1, passim.

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available only if it was "accepted by the public and sold in considerable quantities."[97]

A. High Fidelity from the Bottom Up: 1942-1945

During World War II, the prospects for that larger market increased considerably. As early as June 1942, writers enthused over postwar prospects for the technology. Hundreds of manufacturers developed the capacity for mass production of precision parts which could be devoted to better sound reproduction. The editor of Radio, the magazine for "Radio, Sound, and Electronics," predicted "a huge market for new and improved radio and electronic equipment." Both the public and engineers had "a right to hope for something better from radio in the post-war world."[98]

Military demand also led to the mass production of men trained in the use of electronics for radar, sonar, range-finding, and FM communications systems. Philco alone trained 25,000 technicians at its school in Philadelphia. A significant number specialized in the relationship of electronics to sound; two Western Electric Company engineers taught a

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[97]Harry F. Olson, "Extending the Range of Acoustic Reproducers," Proceedings of the Radio Club of America 18, no. 1 (January 1941), 1, 9.

[98]John H. Potts, "Audio Aspects of Postwar Radio Engineering," PIRE 35, no. 12 (December 1947): 1404; [H. E. Muhleman], "Editorial: Post-War," Radio, June 1942, 4. Given publishing schedules, Muhleman probably wrote this well before the outcome at Midway was announced that month.

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series of courses on sound engineering in Los Angeles.[99] While the education helped create a postwar audience for high fidelity, many of those responsible for postwar innovations benefited from military employment or contract work. Robert Furst learned about FM radio for military applications and applied that experience to consumer receivers in the late 1940s. David Hafler's exposure to electronics in the Coast Guard led to a career in high-quality audio transformers. Arthur A. Janszen's work at the Harvard Underwater Sound Laboratory led to a career in acoustics research and loudspeaker innovation. Frank H. McIntosh's company became involved with industrial audio amplifiers, which led to the development of an amplifier that became a benchmark component for high fidelity. A. M. Poniatoff began his magnetic recording company during the war and commercialized the German Magnetophon afterward for use by radio networks and record companies.[100]

The use of electronics and recorded entertainment overseas also raised the consciousness of American soldiers to the notion of high fidelity.

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[99]Robert Teitelman, Profits of Science: The American Marriage of Business and Technology (New York: 1994), 62; John G. Frayne and Halley Wolfe, Elements of Sound Recording, (New York: 1949), v.

[100]See the capsule autobiographies under these mens' names in "Audio Pioneers of the People and by the People," Audio, May 1962, 44-5, 48-50, 54-6; W. W. Wetzel, magnetic-tape research director for Minnesota Mining and Manufacturing Company after the war, also moved into high-fidelity development as a result of wartime employment: John M. Conly, "They Shall Have Music: Tape Recording," Atlantic Monthly, February 1954, 92.

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When the electronics specialists were not on duty, they took up the challenge of making phonographs that reproduced more of the sound on the V-Disks. The military did not provide for a playback system equal to the output of the custom-made records. Since soldiers in many areas had no power supply, the armed forces' Special Services branch distributed springwound phonographs. This "plywood squawk-box," as a veteran recalled the machine, had the same heavy pickup of his parents' generation to amplify the sound. At the same time it wore out the Vinylite grooves. One sergeant's foraging of parts in New Guinea to electrify a phonograph for V-Disks led to a career in customized home audio in New York City.[101]

B. High Fidelity After the War: 1946-1947

World War II expanded not only the audience for better sound, but the techniques and materials by which producers could fill that demand. RCA Victor's Vinylite Red Seal records were one offshoot. Curiously, Canby had nothing to say in 1946 about the other innovation frequently regarded as one of the two triggers for the high fidelity movement in the United States.[102] That summer, the British company Decca Records launched an American subsidiary, London Gramophone Corporation. London offered a recording of Stravinsky's Petrouchka using "Full Frequency Range

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[101]John M. Conly, "They Shall Have Music: Read All About It . . . ," Atlantic Monthly, February 1952, 90.

[102]Harold Lawrence, "About Music: 15 Years Later," Audio, May 1962, 84; Gelatt, 282-83; Read and Welch, 338.

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Recording," or FFrr, on discs made of a high percentage of high-grade shellac available through the English market. London also put on sale an inexpensive record player designed to playback that range properly.[103]

The process was a direct consequence of the war, developed by British Decca's chief engineer, Arthur C. W. Haddy. Haddy had been tinkering with high fidelity recording techniques since 1935 when, in 1943, the Royal Air Force's Coastal Command requested records that would reproduce the difference in the sounds generated by German and British submarines. In Haddy's words, "That meant high fidelity and the chance to conduct all necessary experiments under the best possible conditions. We went all out on it in a way that probably would have taken years in peace time." Most of this work related to the recording process. Haddy and his team improved the cutting head and developed a lateral-feedback recorder and amplifier that provided a flat frequency response between 40 and 15,000 cps. A year later Decca began combining this equipment with Wallace Sabine's research on reverberation times and microphone techniques for commercial recordings before it formally debuted the process on discs containing a high

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[103]Vin Zelluff, ed., "Tubes at Work: High-Fidelity Phonograph," Electronics, December 1946, 178.

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percentage of shellac after the war.[104]

C. High Fidelity from the Top Down: 1946

At the same time that the London disc and phonograph appeared, Henry Luce's magazine for affluent businessmen, Fortune, published an article under the innocuous title, "Music for the Home." The author began with the thesis that the "American public is getting a poor deal today in . . . musical reproduction." Despite the promises of wartime innovations, nothing was likely to replace the radio-phonograph combination. What then did listeners hear, and what could they expect to hear in the future?[105]

The answers were, not much, and little more, if the relevant industries maintained their attitudes toward sound quality. The writer described the regulatory and economic limitations on radio and the weaknesses of amplifiers, loudspeakers, phonographs, pickups, and records.

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[104]The most extensive source is Irving Kolodin, "Turntable Talk with Arthur Haddy," SRL, July 28, 1951, 35-36, 50, quote on 36. See also Roland Gelatt, "The Other Side," SRL, October 25, 1947, 61; "Decca–The Upstart Reaches 70," http://homepages.enterprise.net/beulah/ffrr/decca.html, visited January 25, 2000; A. C. W. Haddy, "'ffrr' Lateral Feedback Recorder," in H. E. Roys, ed., Disc Recording and Reproduction, (Stroudsburg, Pennsylvania: 1978), 65; Gelatt, 282; and Sanjek, 227. For more on Decca's recording techniques that accompanied the technological developments, see Michael Gray, "From the Golden Age: The Birth of Decca/London Stereo," The Abolute Sound 43 (1985), 103-110; and Gray and Robert Moon, Full Frequency Stereophonic Sound (San Francisco: 1990). Decca's role in closing out the Battle of the Atlantic is not mentioned in Willem Hackman, Seek & Strike: Sonar, Anti-Submarine Warfare and the Royal Navy 1914-1954, (London: 1984). My thanks to Dr. Jon T. Sumida, University of Maryland, College Park, for suggesting this reference.

[105]"Music for the Home," Fortune, October 1946, 156-60, 190-95.

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These combined to limit sound reproduction to a noisy 5,000 cps. Combinations available for that Christmas offered undistorted reproduction up to 8,000 cps, the writer's minimum for high fidelity.[106]

Was the improvement worth the $400-$1,400 for a new console? The reader was given the perspectives of the "golden ears" by audiophile Thomas R. Kennedy, jr., of New York City, and the tin ears in the collective judgment of the consumer by the broadcast and consumer sound industries. Kennedy, a radio engineer, was a purist. He damped his turntable in six hundred pounds of sand and monitored the effect of humidity on his Rochelle salt crystal pickup with a hygrometer. Kennedy dismissed suggestions of fetishism with the comment that anyone who listened to his system would "go home and throw rocks at your set."[107]

Assembled against Kennedy were the industrial interests with enormous investments in AM radio and coaxial network cables, patents, and factories. Even the writer seemed defeated by the evidence of mass market preferences for limited fidelity. He could only assert the "musical public" was ready "to appreciate fine music" on "instruments of better design" even if ninety-five percent of professional musicians were not.[108]

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[106]Ibid., 156-60.

[107]Ibid., 190, quote on 161.

[108]Ibid., 161, quotes on 190.

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Section VI: Defining High Fidelity: The Music Critic as Consumer, 1946-1947

But what could people hear and what did they want to hear from their phonographs? The two questions were interrelated in a market culture and neither admitted of a straight answer. "High fidelity" meant better reproduced sound, but neither music critics nor engineers could agree to what the reproduction should be compared, or who should be the final arbiter of the quality of reproduction. On the question of preferences rested the investment decisions of the broadcasters and major manufacturers. More fidelity cost more money, and before they upgraded their facilities, they wanted to know whether the public cared as much about the form as the content of reproduced sound.

The most influential record critic mulled the first issue with some regularity. Edwin Tatnall Canby was raised in an affluent family, educated at Harvard in music, and employed at Princeton University to teach the subject. From prep school on, he had access to expensive phonographs and components, and at Princeton he fell in with the math and physics faculty who traded an education in engineering for one in music. Unlike most critics, Canby had foreseen the "whole 'audio' development, hi-fi and all, and the spread of recorded music" since the Depression. "Anybody could

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have seen it coming. I did. . . . What astonishes me is that everbody else didn't fall in too."[109]

In 1945, Canby started reviewing records for the The Saturday Review of Literature. Unlike earlier critics who catered to the music lover clique, Canby tried to legitimate the recording and its criticism in three ways. The venue associated classical record consumption with book purchases and the many motivations and subjects for reading. Second, "music lovers" and "record collectors" became "record buyers" in Canby's writing.[110] Those who listened to classical records were no longer fanatics or obscurantists, but part of the larger American culture. Finally, by placing records in the context of changes in the industry, Canby made the field less esoteric. Writing easily with a patronizing self-assurance, he crisscrossed between critiques of sound and music. His reviews stood out because he rated "Engineering" under the subheadings of balance, realism, and record

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[109]Edward Tatnall Canby, "Record Revue: How I Fell Into Audio," Audio Engineering, March 1952, 38-41, quotes on 38; and "Record Revue: I Fall Further into Audio," Audio Engineering, April 1952, 36-38. Canby added further recollections in "Audio Etc.: Radio Recall," Audio, June 1994, 14-18.

[110]Canby first referred to the "record buying public" in "The New Recordings," SRL, February 6, 1946, 26, and to the "record buyer" in "The New Recordings," SRL, April 13, 1946, 92. In this trend he followed that of the leading record magazine, which changed from The American Music Lover to The American Record Guide before the war.

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surface, as well as the artistry of the performance.[111] Canby made it his mission to promote "complete understanding and cooperation between engineer and musician." He would explain the issues involved in making a record to "the record buying public, which so often is unwittingly guilty of unfair judgments against both engineers and musicians."[112]

Canby treated the issue of high fidelity on a regular basis. In January 1946, he defined it as the "faithful reproduction of music" and stated that radio and record listeners "haven't had it." FM and better records proferred "genuine high fidelity--electrical reproduction that is . . . a reasonable facsimile of the original." Noting the public's conditioning by bad reproduction, Canby called for "a better understanding of the esthetic factors involved in perfect high fidelity reproduction" by the public and by engineers.[113]

By the end of the year, Canby was enthused enough about the promise of FM and phonograph technology that he urged his readers to buy only radio-phonograph combinations that had an improved pickup and speaker that could accomodate a frequency range at least double that

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[111]See Canby's column in SRL, February 6, 1946, 41, for his definitions of these categories.

[112]Edward Tatnall Canby, "The New Recordings," SRL, February 6, 1946, 26.

[113][Edward Tatnall Canby], "The New Recordings," SRL, January 19, 1946, 43.

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available before the war. The key, however, was FM. It meant "a fundamental change in the standards of fidelity you will require in your new equipment" and in the sound that one heard.[114]

Canby also began contributing a column in 1947 to Audio Engineering, renamed from Radio in May. John H. Potts, the editor, turned the magazine into a forum around which audiophiles--amateur and professional sound engineers--could congregate and develop standards for the burgeoning industry.[115] Supported by a doubling in sales from five to ten thousand in four months and advertising from hundreds of component manufacturers, Potts focused on the relationship between music and sound. Beginning in June, he sponsored a seven-part "series of articles on music theory, written especially for sound engineers," that covered the subject from musical instruments and room acoustics to stylus-groove relationships and the human ear. As the question arose of what listeners preferred to hear, limited or high fidelity, Audio Engineering became the

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[114]Edward Tatnall Canby, "The New Recordings: Don't Buy It!" SRL, December 7, 1946, 99.

[115][John H. Potts], "Transients: Introducing 'Audio Engineering,'" Audio Engineering, May 1947, 4.

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primary forum for engineers to debate the issue, Potts siding with those arguing for improved reproduction.[116]

Canby's "Record Revue," a feature "unique in a technical magazine," was included because "so many of our readers are record fans after hours."[117] It appeared to be an opportunity to cross the bridge he started building at the Review, but Canby found himself stepping gingerly between the world's best sound engineers and the world's best music lovers. A year after he first expressed his opinion on high fidelity in the Review, Canby was reluctant to give a firm definition to his new audience. The new pickups and improved recordings provided "almost limitless" frequency response and so little noise in the groove "that the listener is scarcely aware of the actual pickup and record at all--the music holds the field to itself."[118] By the end of the year, he merely applauded "every improvement in fidelity" without defining it. Instead he concluded that "there can be little

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[116][John H. Potts], "Editor's Report: Progress Report," Audio Engineering, September 1947, 4; Benjamin F. Tillotson, "Musical Acoustics," Audio Engineering, June-December 1947.

[117][Potts], "Transients: Introducing 'Audio Engineering,'" 4.

[118]Edward Tatnall Canby, "Record Revue," Audio Engineering, June 1947, 33.

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argument, among sound men, as to what constitutes 'better' in general terms."[119]

Writing in the Review in October, however, Canby committed himself to "its original common-sense meaning . . . a relatively high degree of naturalness, of faithfulness to the imagined original sound." For the music lovers he went a step further, breaking the concept into two parts. The "illusion of reality" depended on the capture of the "rightly calculated sound" by microphone placement and acoustical control. While Canby acknowledged that much more took place in the transmission from microphones onward, this distinction left him asserting that "even the oldest" European recordings of piano pieces offered "a type of genuine fidelity that has not been matched in spite of our vaunted 'high fidelity.'"[120]

Canby found it difficult explaining to engineers the difference between aesthetic and technical fidelity that he had declared. In the next AE column, he emphasized only that all reproduction was an illusion because it referred to an "imagined original": those who heard the reproduction

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[119]Edward Tatnall Canby, "Record Revue," Audio Engineering, October 1947, 29.

[120]Edward Tatnall Canby, "Some Highs and Lows," SRL, October 25, 1947, 62.

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would never hear the original performance.[121] It was a point with which the engineers could not argue.

When he returned to the second part of his definition in the next Review, Canby went further. His enthusiasm of 1946 for wide frequency range disappeared. Music lovers who bought the new records and pickups would find that the rest of their systems revealed the problem of distortion, "in the higher tones" which previously had been suppressed. Conscious of his readers' budgets, Canby could not urge them to start over, or adapt their systems as the engineers did. Rather, he concluded weakly, "Don't misjudge 'high fidelity' until you've actually heard it!"[122]

Section VII: Defining High Fidelity: The Inventor and the Producer, 1944-1947

Those at RCA who had a vested interest in the AM radio and the promise of television regarded the issue similarly. O. B. Hanson, chief engineer of NBC since its inception in 1926, was not opposed to FM. He agreed that a wide, undistorted frequency range was desirable but questioned the emphasis on 15,000 cps frequency reproduction. In a report to the wartime Radio Technical Planning Board, Hanson highlighted three physical problems in sound reception. The higher a frequency, the more

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[121]Edward Tatnall Canby, "Record Revue," Audio Engineering, November 1947, 34.

[122]Edward Tatnall Canby, "Some Highs and Lows: How High is Fidelity?" SRL, November 29, 1947, 63.

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directional it became, and few loudspeakers were built to disperse the frequencies off-center. How many people in a household could sit directly in front of the speaker? The lower the volume of the radio, the greater the dropoff at the low and high ends of the frequency range. Who listened to radio at a volume where they could hear the high and low frequencies above background noise? Who, for that matter, had ears young enough to pick up high frequencies at all? Hanson urged that everyone "get down to earth in the matter of high fidelity" and concentrate on resolving the distortions and noises present in contemporary radios rather than strive for "a theoretically complete audio spectrum."[123]

Hanson's call for a limited high fidelity reached the engineering and enthusiast communities in 1944 through a reprint in Radio and gained support from other authorities.[124] More writers joined in the effort to explain the relationship between frequency and loudness as well as other distortions generated by playback systems. The ear's perception of the

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[123]G. M. Nixon, C. A. Rackney, and O. B. Hanson, "Down to Earth on 'High Fidelity,'" March 27, 1944, reprinted in "Reports on Standards and Frequency Allocations for Postwar FM Broadcasting," Radio Planning Board, Panel 5, June 1944, copy in E. H. Armstrong Papers, box 159, Columbia University Special Collections, quotes from emailed copy courtesy of Gary Frost.

[124]McMurdo Silver, "High Fidelity," Radio-Craft, March 1945, 347, 380-82; Emerick Toth, "High Fidelity Reproduction of Music," Electronics, June 1947, 113. Silver, a "high-fidelity sound pioneer," was a regular contributor to the magazine; Toth wrote from the Radio Division of the Naval Research Laboratory. Hanson's article was reprinted in Radio, October 1944.

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relative loudness of different frequencies depended on the intensity of the sound. A bass drum or a triangle sounded much quieter compared to mid-range sounds when reproduced at low volume. Since most listeners did not play music at the level heard in a concert hall, engineers added tone controls to boost the bass and, increasingly, the treble, for household reproduction.[125]

But how was an engineer to determine where frequency and intensity should compensation begin or end? How were these circuits to give an illusion of fidelity to the original performance? One engineer agreed that, rather than attempt the impossible of bringing the listener to the performance, the industry should do the opposite. Listening to a monaural source at lower volume with greater background noise "cannot possibly 'sound like the original.'" Others urged their peers to "make a practice of occasionally attending symphonies and listening to live dance bands, with a conscious effort toward improving his audio discrimination." Another called for greater interaction between acousticians and musicians with the aim of developing a common terminology for music as an art and science as well as criteria for "measurement of music and its effect on people."[126]

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[125]John G. Goodell and B. M. H. Michel, "Auditory Perception," Electronics, July 1946, 142.

[126]First quote from Lawrence V. Wells to the editor, PIRE 35, no. 4 (April 1947), 378; second quote from Goodell and Michel, "Auditory Perception," 142; third from Harold Burris-Meyer, "The Place of Acoustics in the Future of Music," IASA 19, no. 4 (July 1947), 534. See also Benjamin F. Tillson's comments on "Musical Education" in "Musical Acoustics: Part IV," Audio Engineering, September 1947, 30-31.

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A. CBS's Tin Ears vs. RCA's Golden Ears, 1945-1947

Not every engineer involved with sound reproduction felt as much concern. Like the smaller and pop-oriented labels, CBS and its subsidiary, Columbia Records, had little financial stake in better sound.[127] Unlike RCA, CBS did not manufacture radios or phonographs; it only broadcast content and manufactured records. If it was true that most people preferred lower fidelity, then CBS felt less obligation to innovate a better sound in the content that it sold. Like RCA in 1939, it undertook a survey to find out what the audience preferred as the war ended.

While RCA never made the results of its 1939 survey public, CBS showed no reluctance six years later. Philip Eisenberg and Howard Chinn, a psychologist and an engineer at CBS, collaborated on a similar survey that raised basic questions about the nature of sound reproduction. Categorized by age, sex, musical training, education, and FM radio ownership, nearly five hundred listeners indicated their preferences for different frequency and volume ranges in recorded and live broadcasts. No group expressed a majority preference for wide-range frequency response, although FM listeners changed their minds when informed that they had heard a wide-range sample. Because of the live samples and everyone's experience with

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[127]CBS commissioned a survey in June 1946 on the record market for its company-owned stations that asked no questions about sound quality: Surveys Divsion, CBS Research Department, "Selected Data on Musical Preferences and the Market for Records" May 1947, Performing Arts Division, Library of Congress.

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high fidelity in everyday life, the authors rejected the suggestion that people had been conditioned to accept limited response. They could only conclude that "a narrow tonal range is preferred because it sounds better."[128]

Many engineers thought this conclusion counterintuitive. At a discussion during the 1946 meeting of the Institute of Radio Engineers, critics argued that the system used must have suffered from various forms of distortion, that listeners were conditioned to prefer inferior broadcast sound, and that the CBS tests implied most people would prefer live performances with similar restrictions. Surely "something could be determined experimentally about absolute preferences, and that . . . would be very desirable for . . . determining . . . the aim of the engineer."[129]

Chinn, Eisenberg, and their supporters pointed out that they had tested only monaural sound, not the binaural effect experienced at a concert. Yet they did not make clear whether they felt stereophonic radio was commerically unrealistic or that listeners' preferences would vary with more channels. Instead they refused to accept the notion of any ideal sound

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[128]Howard A. Chinn and Philip Eisenberg, "Tonal-Range and Sound-Intensity Preferences of Broadcast Listeners," PIRE 33, no. 9 (September 1945): 571-81; also in Journal of Experimental Psychology 35, no. 5 (October 1945): 374-90; quote from Eisenberg and Chinn, "Tonal Range Preferred of Listeners: Results of Study Show Liking for Narrow Reproduction," Broadcasting-Broadcasting Advertising, September 17, 1945, 30. My thanks to Gary Frost for providing the latter citation.

[129]Walter van B. Roberts, in "Discussion on 'Tonal-Range and Sound-Intensity Preferences of Broadcast Listeners,'" PIRE 34, no. 10 (October 1946), 757-58.

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unless someone could provide "experimental or theoretical evidence." Scientists should pursue perfection as a goal but, they asked, "what is perfection?" Was it a new and better device for reproducing sound, or was it "reproducing sound the way people like it?"[130] They released another study with more controls that supported the latter goal as more legitimate.[131]

B. Harry Olson and Acoustic Research, 1945-1947

The Chinn-Eisenberg studies served to reinforce suspicions that corporate producers opposed offering better sound to consumers. Manufacturers added inferior FM circuits to match those for AM in their radios.[132] During the debate within the engineering community, however,

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[130]Quotes in ibid., 760; see also James Moir to the editor, PIRE 35, no. 5 (May 1947), 495, and J. Moir, "Perfect vs. Pleasing Reproduction," Audio Engineering, June 1947, 24-27, 41-43, originally in Electronic Engineering (U.K.), January 1947.

[131]Howard A. Chinn and Philip Eisenberg, "Influence of Reproducing System on Tonal-Range Preferences," PIRE 36, no. 5 (May 1948), 572-77. Chinn and Eisenberg also investigated listener preferences for loudness, relative and absolute, of broadcasts. Their results were less controversial, although the findings that most people preferred an even level of sound and the same level for speech and music were further indicators that most people were not interested in the dynamic possibilities of high fidelity: Howard A. Chinn and Philip Eisenberg, "New C.B.S. Program Transmission Standards," PIRE 35 no. 12 (December 1947), 1547-55.

[132]This argument arises most often in relation to Armstrong's efforts to promote FM radio before and after World War II. Susan Douglas follows this line most recently in Listening In, 262-63. See also Read and Welch, 338, for their understanding of the international corporate agreements behind the suppression of British-developed phonographs in the U. S. after World War II.

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both sides were aware of other corporate research on what people liked to hear.[133] Olson was especially annoyed by the CBS conclusions. These tests, like the earlier ones at RCA Victor, Bell Labs, and NBC, were subject to at least six forms of nonlinear distortion as well as other forms of noise.[134] Well before Chinn and Eisenberg published their findings, Olson proposed a preference test using a live orchestra. If people preferred a limited frequency range instead of the 20,000 cps that Olson understood to represent the outer limits of human hearing, then perhaps "the public would like an orchestra better if it were surrounded by a . . . filter which eliminated the high frequency sound."[135]

Olson did not receive funding until 1946. After a thousand listeners listened to his band at the Princeton Labs with and without a filter, he announced the results. Over two thirds of the audience preferred full-range reproduction. Olson had looked "at the fundamental problem--whether people do or do not have a definite choice between . . . natural music sound

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[133]See Walter van B. Roberts, 758, and Eisenberg and Chinn, 759, in "Discussion on 'Tonal-Range.'" Roberts worked at Palmer Physical Laboratory at Princeton University and presumably knew about Olson's research.

[134]Harry F. Olson, "Subjective Frequency Tests," RCA Laboratories Report Z-2, January 17, 1944, pp. 1-2, Hagley 2069, series XXII, box 143.

[135]Ibid., 2-4; quote, 4.

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compared to just a portion of it. The answer is, they do."[136] He concluded that the problem with earlier tests lay not with the listeners' conditioning but with the quality of reproduction, and his 1947 article helped revive research into record systems distortion.[137]

Among professional engineers, Olson's tests did not resolve either the question of definition or preference. In November 1948, the Acoustical Society of America convened a panel at its annual conference on "What Constitutes High Fidelity Reproduction?" The panelists included J. P. Maxfield, who had initiated the discussion with the rationalized electrical recording; Semi J. Begun, the leading authority on magnetic techniques; W. B. Snow, one of the Bell engineers responsible for the early stereophonic systems; and Olson. The first three assumed high fidelity meant an undistorted, wide-range reproduction of the sound entering the

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[136]"Radio Laboratory Tests Show Taste for Natural Music Tones," [Philadelphia Inquirer? May 10, 1947?], clipping in back of patent disclosure binder: "Reprints of Papers by Harry F. Olson," Olson Papers.

[137]Harry F. Olson, "Frequency Range Preference for Speech and Music," Journal of the Acoustic Society of America 19 no. 4 (July 1947): 549-55, published also in RCA's Broadcast News 46 (September 1947), 28-32. See also Olson's oral history at www.ieee.org/organizations/history_center/oral_histories/transcript/olson.html, visited March 1, 2000. For an explanation of the difference in results, see N. M. Haynes, "Factors Influencing Studies of Audio Reproduction Quality," Audio Engineering, October 1947, 15-17, 35; and Stephen E. Stuntz, "The Effect of Sound Intensity Level on Judgment of 'Tonal Range' and 'Volume Level,'" Audio Engineering, June 1951, 17-19, 26. Carson et al., "A Record Changer," 179, credit Olson for their refinements to the 45's design.

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microphone; all accepted that the cost of this goal for the mass consumer was uneconomical. Therefore, as Snow proposed, engineers should work with listeners to produce "a satisfactory impression of the sound."[138]

Olson disagreed. In what the reviewer called "the most informative and original paper of the symposium," he explained how the components in $300 consoles could be upgraded at minimal cost to reduce the many distortions that alienated listeners from high fidelity. For Olson, a bridge to the ideal could be built to the general public more rapidly than many of his peers thought.[139]

Olson's work gained acclaim and support from the audio-related press.[140] Audio gave another engineer's "deliberately challenging" paper on the "beneficial commercial effect" of high fidelity. In it, C. J. LeBel highlighted the problem of "listener fatigue" that occured from high-frequency IMD. The distortion was quantifiable; the fatigue, which occured somewhere in the brain, was not. Nontheless, it existed, based on experiences in hearing aid research and motion picture theatres, where the

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[138]"What Constitutes High Fidelity?" Audio Engineering, December 1948, 8, 36-38, quote on 8.

[139]Ibid., 36-38.

[140][John H. Potts], "Transients: High Fidelity," Audio Engineering, May 1947, 4; "Report on Dr. Harry F. Olson's Listener Preference Tests," Audio Engineering, June 1947, 27, 43-44; "Today's Radio and Television: Not What They Ought to Be," Consumers' Research Bulletin, February 1948, 24-25; "The Average Listener," Radio & Television News, May 1949, 153-54.

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audience had no distraction from the reproduction. LeBel argued that producers should cater to the half of the population not satisfied with limited reproduction, for "every time a listener yawns and turns off his set, his ears have won a victory."[141]

RCA supported Olson's campaign. He had laid the groundwork to maintain the company's technical reputation and profit margins if the general public responded to the call of the audiophiles. The connection is more clear when his interpretation of listener preferences is related to RCA Victor's signal event of 1947. In August the division underwrote a train full of music critics from Manhattan to the Berkshire Music Festival in Tanglewood, Massachusetts.[142] There, they and twelve thousand music lovers heard and saw the Boston Symphony match performances with the RCA Victor's "Festival Series" of radio-television-phonograph combinations.

There was nothing new about this comparison except in the refinement in masking the deficiencies of sound reproduction. Thomas Edison had hidden the monophonic nature of his records by recording soloists; Olson arranged to play his monophonic system in the festival's Music Shed. Because of its open-air design, "the perspective of the orchestra

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[141]C. J. LeBel, "Psycho-Acoustic Aspects of Higher Quality Reproduction," Audio Engineering, January 1949, 9-11, 32-4, quote on 34.

[142]"Golden Ears and Tin Ears," Newsweek, August 11, 1947, 82.

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is lost" for most listeners, meaning that they heard the symphony itself without a stereo effect.[143] Olson arrayed twelve of his Duo Cone loudspeakers at the front of the stage at the point where microphones had recorded the last four minutes of Beethoven's "Egmont" overture earlier. Powered by three forty-watt amplifiers, the speakers matched the acoustics and the sound level of the orchestra.[144]

The key improvements in the new systems lay in the speaker, which reproduced sound from thirty to fifteen thousand cycles over a ninety-degree arc with little distortion; and a "threshold noise suppressor" that Olson held to be an improvement over H. H. Scott's much-touted circuit.[145] No one was completely fooled but even some of the critics "were not quite

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[143]Harry F. Olson, "Wide Range Reproducers and the Tanglewood Demonstrations," PEM-79, August 18, 1947, 9, 10, Sarnoff Corporation Library. This should also be available in Hagley 2069, series III: "Princeton Lab technical reports."

[144]Ibid., 10-11.

[145]Ibid., 4-7, 8; Harry F. Olson, "Audio Noise Reduction," Electronics, December 1947, 118-22; and Edward Dickey, ed., "National Electronics Conference: Technical Papers," RCA Laboratories Division News, December 1947, 2, Sarnoff Corporation library, which notes Scott's vague terminology and lack of data. For coverage of Scott's invention, see "Hasn't Scratched Yet," Newsweek, January 6, 1947, 65; "Shorts and Faces: Music Without Noise," Fortune, June 1947, 148-50; H. H. Scott, "Dynamic Suppression of Phonograph Record Noise," Electronics, December 1946, 92-95; H. H. Scott, "Dynamic Noise Suppressor," Electronics, December 1947, 96-101; Edward Tatnall Canby, "Record Revue," Audio Engineering, May 1948, 24, 38-41.

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sure which was performing."[146] All in all, "even the most cynical critic had to admit he had been impressed" at the sound that could be had for $1,800 to $4,000 from RCA Victor's new Consumer Custom Products Department.[147]

C. The Consequences for RCA Victor's Records, 1945-1947

While Olson upheld the notion of high fidelity and improved loudspeakers, others at RCA Victor pursued the problems of distortion in records. In 1945, H. E. Roys began studying the intermodulation distortion (IMD) generated by two frequencies reproduced simultaneously in a groove. IMD, like harmonic distortion, arose from the variation between the path traced in the groove by the reproducing stylus and that cut by the recording stylus. Mathematical analysis and tests with a variety of record diameters, stylus radii, and groove speeds indicated that listeners could not discern IMD of less than ten percent. Higher percentages arose from two sources. In the plating process that generated stampers from the original recording, the polishing of the metallized grooves at each step abraded the grooves. The extended use of stampers also produced records with distorted grooves. While these were matters for the manufacturers to address, Roys also found that current stylus standards resulted in "objectionable tracing distortion."

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[146]Irving Kolodin for the New York Sun, quoted in Olson, "Wide Range Reproducers," 14.

[147]"Golden Ears and Tin Ears," 82; "New Custom-Built Series of Instruments Introduced by RCA Victor Division," RCA Laboratories Division News, September 1947, 13; "Introducing the 'Berkshire,'" Radio Age 7, no. 1 (October 1947): 22-23.

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He recommended the use of smaller-radius playback styli when manufacturers could mass-produce them. Carson's team applied Roys's work to the sound of the 45, while Olson's group put fine-groove "New Style Records" on its agenda in the spring of 1948.[148]

Section VIII: What the Consumers Heard: the Promotion of Columbia, 1945-1948

The favorable attention that Olson's and Roys's work received professionally did not translate into greater respect for RCA among audiophiles. The Berkshire line offered fine sound, but not at a price that most in that group could afford. More important, however, was the difference in philosophies between the audiophiles and RCA. Part of the attraction of seeking out high fidelity was the independence engendered by tinkering with and assembling the components to suit one's own tastes. Each man put his own stamp on the reproduction, becoming an engineer and producer in his own home. Canby catered to this desire, criticizing the

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[148]H. E. Roys, "Improvement in the Quality of Phonograph Reproduction," RCA Victor TR-1006, December 18, 1947, quote on p. 9, Hagley 2069, series XXI, box 121; H. E. Roys, "Intermodulation Distortion Analysis as Applied to Disk Recording and Reproducing Equipment," PIRE 35 (October 1947): 1149-52; Murlan S. Corrington, "Tracing Distortion in Phonograph Records," RCA Review 10, no. 12 (1949): 241-53; H. F. Olson, "Preliminary Program Phonograph Record Research," witnessed May 3, 1948, 7-8, in Herbert Belar's RCA Laboratories notebook P-4613, Sarnoff Corporation Library. One company's lacquer masters showed three to four percent IMD, compared to ten to twenty percent on the records: LeBel, "Psycho-Acoustic Aspects," 11. Carson et al., "A Record Changer,"179, implicitly admit sound quality had not been a mandate in 1939 by stating only that high fidelity had been "an engineering objective for some time." They cite Roys's work on 180.

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convenience of consoles and calling for standard cabinets that could "house any and all components." For RCA Victor and other large manufacturers, this approach threatened their profit margins and trademarks. As Olson pointed out, cabinetry accounted for "a great deal" of the set's cost. RCA would lose control of the quality of sound reproduction if it built cabinets in which others could install equipment.[149] Olson may have been trying to extend the appreciation of high fidelity, but the interests of the corporation and the predilections of the audiophiles, as well the prejudices of their champions, left an unbridgeable gap.

The same was true in records, despite the efforts of RCA Victor's engineers in that department. In large part that was due to Edward Canby and the other critics at The Saturday Review. First, experiences as an amateur engineer notwithstanding, Canby did not understand all that went into a good-sounding record. Second, for all of his interest in bridging the gaps between musician, engineer, and consumer, Canby, and the Review's "Recordings" section focused on the classical record market and ignored the broader interests and strategies of the major record labels, in particular those of Columbia and Victor. As in the late 1920s, Columbia under Wallerstein continued to build its reputation from the top down. This meant attacking Victor's dominance in the classical field, which Victor maintained after

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[149]Edward Tatnall Canby, "Record Revue: Classical Records," Audio Engineering, February 1948, 32, 43-45, and March 1948, 32, 38-40, quote on 32; "What Constitutes High Fidelity," 36.

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World War II, and catering to the music lovers Wallerstein had worked with in the 1930s.

Columbia's efforts complemented those at RCA Victor. Franklin M. Folsom, whom Sarnoff promoted to executive vice-president of RCA Victor in December 1945, pursued a marketing philosophy based on General Motors research and his experiences at Montgomery Ward. Under his leadership, RCA targeted the middle eighty percent of consumers, the broad American middle-class.[150]

Folsom was thinking of economic groups, but the category applied to taste as well. As that view trickled down to James Murray and Victor Records, however, it also meant cultural levels. J. Walter Thompson, which took over the Victor Records account in 1943, advocated reaching a broader market for records, especially the premium Red Seals, despite the reservations of label executives during World War II. Maitland Jones, head of the account group in 1945, lobbied successfully with RCA Victor operating vice-president John G. Wilson and Murray, now vice-president for Victor records, to emphasize popular music and popular classics in order to expand the market for records.[151]

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[150]Hartwell, "The Man Who Sells," 102-103. It is not clear if Folsom identified this market independently.

[151]"RCA Executives Promoted," Radio Age 5, no. 2 (January 1946) 22; "Case Report on RCA Victor Records," 11-14, 30-40, and Exhibits D and J, "RCA Victor Advertising Outlay, Popular vs. Classical" and "JWT Personnel Handling RCA Victor Records," 100 and 108, respectively. See also the

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Thompson's strategy did nothing to endear Victor to the music lovers who had supported the industry for twenty years. The label continued to issue recordings receiving favorable reviews. But it focused less on the esoteric compositions sought by music lovers and more on the standard repertoire heard, usually as background to other activities, by the middle-brow audience.[152]

Canby's and J. Walter Thompson's effort to expand the classical records field became a battle of culture and commerce. Canby and the coterie that joined him at the Review struggled to imbue the newly middle class after World War II with the aesthetic and tradition of music appreciation that they had learned and developed in the 1930s.[153] The agency and its client sought to sell higher-priced records to the same group by promoting the most accessible recordings. As a result, Canby, Irving Kolodin, and others favored Columbia and its strategy in myriad ways. Canby concluded that Victor's shellac pressings had surfaces as fine as their plastic ones, even

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Columbia ads in the D'Arcy Masius Benton & Bowles collection, box 44, folder 61, Hartman Center; all of those retained for the postwar period promote classical recordings.

[152]See Robert Jourdain, Music, the Brain, and Ecstasy: How Music Captures Our Imagination (New York: 1997), Chapter 8, "To Listening . . .," especially 245-49, for a detailed analysis of the differnence between hearing and listening.

[153]In late 1947, the SRL expanded Canby's column into a monthly section edited by Irving Kolodin, a move that attracted the notice of Newsweek: "Music to Read About," September 1, 1947, .

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as he opined that the abrasives in the former were "on the way out."[154] Ignorant of the stamper's role in contributing to surface noise, Canby blamed the plastic for the "tiny ticks and sputters" he heard, finding them at least as annoying as needle scratch.[155] He implied that Victor deprived small labels of high-quality plastic, when it seems likely that the labels could not afford Victor's quality controls.[156] It never occurred to Canby that Victor's expansion of productive capacity made possible much of the smaller labels' output.

After Victor engineers took him to task for attributing a "vaguely disappointing" RCA Victor album to poor microphone location, Canby became more cautious in placing blame.[157] He continued to favor Columbia's records for a number of reasons, including its "exceptionally

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[154]Canby, "The New Recordings," SRL, January 12, 1946, 29.

[155]Quote from Edward Tatnall Canby, "The New Recordings: Some Comparisons," SRL, September 14, 1946, 39; idem, "The New Recordings," SRL, January 12, 1946, 29, and February 9, 1946, 41; idem, "Record Revue," Audio Engineering, September 1947, 29.

[156]Edward Tatnall Canby, "The New Recordings," SRL, April 13, 1946, 92; idem, "The New Recordings: Asch, Disc, Union," SRL, May 25, 1946, 45.

[157]Canby, "The New Recordings," SRL, January 26, 1946, 42, and February 6, 1946, 26.

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smooth-working team of musicians and engineers."[158] He praised the label's continued use of shellac "for sound reasons" [159] Despite recognizing that plastic was "a decided improvement . . . both in fidelity and in background hiss," Canby chastized Victor for not warning consumers that older pickups would wear the material faster.[160] Columbia's received more A's for its laminated surfaces than Victor did with its plastic or shellac discs in Canby's monthly evaluations. Shellac, he opined, was "probably more enduring than are any of the flexible plastics to date" and as late as March 1948 he found Victor's shellac surfaces superior to their Vinylite ones.[161]

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[158]Edward Tatnall Canby, "The New Releases: Columbia Releases," SRL, June 29, 1946, 45. Michael Gray, in "A History of the Sound," displays an ambivalence about the label's 78s. On the one hand, Columbia had a "reputation for less than exceptional sound that dogged it throughout the 78 rpm era": 31; on the other, its records "sounded better than any in the classical industry, including Decca's FFRR 78s.": 32.

[159]Edward Tatnall Canby, "The New Recordings," SRL, January 12, 1946, 29.

[160]Quote from Edward Tatnall Canby, "The New Recordings," SRL, January 5, 1946, 22, emphasis in the original; idem, "The New Recordings," Audio Engineering, April 13, 1946, 92.

[161]In a random survey of Canby's surface ratings between January and November 1946, Canby gave Columbia releases fifteen A's to Victor's eight. On the other hand, 79% of Victor's recordings received an A- or better compared to 81% of Columbia's. Quote from "The Discographer" [Edwin Tatnall Canby], "The New Recordings," SRL, January 12, 1946, 29; Canby's review of Toscanini and the NBC Symphony Orchestra's Romeo and Juliette, opus 17 by Hector Berliosz, Victor DM 1160 (3) or Victor DV (7) (3 plastic), Audio Engineering, March 1948, 40-41. By June 1948, Columbia and a host of smaller labels had switched to Vinylite for their 78s: full-page ad for Bakelite Corporation's Vinylite, SRL, June 26, 1948, 45.

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When Columbia began switching to plastic that spring, howver, Canby wrote that its recordings, "with their wider range, justify the use of plastic."[162] Behind all of these technical complaints, Canby reflected the frustrations of other music lovers in the Review's Correspondence columns because Victor, unlike Columbia, held back on restoring its pre-war classical catalog.

For all of these criticisms, however, Canby and other critics found much to praise in the sound of 78s by the time Columbia debuted its LP. By late 1947 someone told him about the equalization techniques engineers had been using since the beginning of electrical recording. Recorded sound did not depend solely on microphone placement, which itself delivered "a new kind of sound, artificial perhaps, but very much alive and realistic nevertheless." Other factors existed that gave "an impression of decidedly greater tonal range."[163] Even in 1949, fourteen of of the thirty-one orchestral and concerted recordings in the Review's annual summary consisted of 78 albums.[164]

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[162]See Canby's review of Pittsburgh Symphony, Symphony no. 40 in G. Minor by W. A. Mozart, Columbia MMV 727 (3 plastic), Audio Engineering, May 1948, 41.

[163]First quote from Canby's review of the Metropolitan Opera Company's Hansel and Gretel, by E. Humperdinck, Columbia M OP 26 (2 vols.), Audio Engineering, November 1949, 46; second quote from idem, "Record Revue," Audio Engineering, November 1949, 34.

[164]"Best of the Year--1949," SRL, December 31, 1949, 45.

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Canby also predicted the future path of innovation in the record industry. In 1946, he inveighed against the "psychological jolts" provided by record changers and argued for a longplaying record. The changer was "a deadly mechanism, and expensive." It destroyed not only records--one that broke Victor discs came to mind--but the peace of mind of the listener. He was forced "to listen to . . . the deadly rhythmical series of clicks and bumps that attend the changer's best efforts . . . tense and ready to spring at the slightest deviation . . . still tense with the possibility that the machine, after all, has merely begun the last record again, or even skipped a side."[165]

At that point Canby concluded that listeners should return to changing their records by hand if "we must (and we must) have 12-inch records, playing at 78 r.p.m."[166] After readers protested, he evaluated alternatives. Film, tape, and wire all promised "unlimited continuity" but were "least likely to replace our records" because replacement involved a systems change that neither producers nor consumers desired. Canby proposed something less radical: a revival of RCA Victor's 1931 radio transcription disc. After fifteen years of experience with the technology, he thought that the phonograph industry should be able to make a sixteen-inch longplaying record and "a heavy, well-balanced, two-speed" turntable

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[165]Edward Tatnall Canby, "The New Recordings: How to Relax," SRL, August 10, 1946, 29. Columbia stopped issuing classical albums for manual changing in 1947: "Editorial Notes," ARG, October 1947, 33-34.

[166]Canby, "The New Recordings: How to Relax," 29.

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which, "with reasonable mass production, . . . should cost no more . . . than the price of a good changer."[167]

The only company making records and players, of course, was Victor, whom Canby never mentioned by name. As he saw it, the problem was that a convenience for the consumers "would involve a billion dollars worth of vested interest" by the company, "if not in actual manufacturing equipment, then in well established publicity routines." Until Victor or someone else resolved that difference in interests, listeners would "keep right on trying to patch [their] symphonies together from the familiar four-minute slices."[168]

Section IX: CBS Invents the LP, 1944-1948

While RCA sat on the 45 and mulled improvements to the 78, CBS began working on the answer to Canby's dreams in 1945.[169] Columbia's

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[167]Canby, "The New Recordings: Record Changer and Other Matters," SRL, August 24, 1946, 31.

[168]Ibid.

[169]The story of the LP's development is based on the recollections of various participants. CBS assigned credit to Peter Goldmark, who embroidered the story in his autobiography with Lee Edson, Maverick Inventor: My Turbulent Years at CBS (New York: 1973). Goldmark, 130, described Wallerstein as "an assertive fellow, full of self-importance," who patronized the CBS research director. C. A. Schicke dedicated Revolution in Sound: A Biography of the Recording Industry, (Boston: 1974), to Wallerstein and assigns him the primary role in negotiations with RCA. Wallerstein's supporters give him more credit for supporting the project than does Frank Stanton, then president of CBS, in his oral history. In the last two years, various retirees have publicized the engineering effort of William S. Bachman. The following narrative attempts to interpolate these accounts within the framework of CBS's place in the communications

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announcement three years later came as a surprise to Canby and the other critics, in part because neither the impetus nor the funding came from Columbia Records. CBS's research director, Peter Goldmark, had been unhappy about the breaks in recordings and the space his record collection occupied. In November, after drawing on papers and patents of Hunt and Pierce on stylus-groove relationships, he showed executives Paul Kesten and Frank Stanton a record with twenty-five minutes of Tchaikovsky's Violin Concerto in D on one side. Turning the physicists' calculations into reality proved difficult, but the amount of distortion was less important to the executives than the prospect of entire symphonic performances on a single record. Such an innovation was of a piece with the promotion of CBS as the "platinum" network, in contrast to the middle-class domination of NBC and its larger number of stations.[170] Kesten budgeted $100,000 for development of a 33 1/3-rpm longplaying record and rights to Hunt and

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industry.

[170]My dating is based on Sally Bedell Smith, In All His Glory, 281, and the premise that the disc Goldmark donated to the Smithsonian Institution was his first attempt at longplaying record; a photograph of it appears in Cynthia Hoover, Music Machines--American Style (Washington, D.C.: 1971), 118. See also Goldmark, 126-27, and "The Reminiscences of Frank Stanton [part 2]," (1991), pp. 104-105, in the Oral History Collection of Columbia University. My thanks to Dr. Stanton and Mary Marshall Clark of the Oral History Research Office for allowing me to read the final draft of the interview. Goldmark, 131, dismisses Hunt and Pierce's work (see Chapter Five, section xvii, 348-49), along with that of Bell Labs as of minor importance. See John Alvin Pierce, "The Phonograph's Forgotten Heros," Audio, March 1991, 46, for the view from Hunt's laboratory at Harvard.

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Pierce's stylus design. The classical record and high-fidelity system would appeal to both classical performers and the high-culture audience frustrated with RCA Victor's middle-brow marketing.[171]

Wallerstein at Columbia Records was less enthused. In 1933 he had pulled Victor's longplaying vinyl disc off the market because of its flaws. Now he refused to take the blame for failed R&D and regularly insisted that the record play longer and better. Goldmark received some help when he hired technician René Snepvangers from NBC's Transcription Department in New York late in 1945. Earlier, however, Snepvangers had worked on stylus-groove research for the FM pickup and the 45 in Camden.[172] Aware of the problems of tracing distortion in Goldmark's goal, Snepvangers warned Goldmark against a longplaying record. By the end of 1946, Goldmark had put only eight minutes on a disc that Wallerstein found acceptable and Hunt rejected Columbia's price for a license on his pickup

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[171]Goldmark, 132-33; Smith, 281. CBS actually caught up with NBC in number of affiliates when the latter had to sell its Blue network in 1942-45. The number did not reflect the size of the audience, however, and Paley continued to promote CBS's reputation for quality.

[172]William S. Bachman notes that "CBS was not unaware of the fine-groove recording work proceeding at RCA" in "The LP and the Single," JAES 25, no. 10/11 (October/November 1977), 823. For Snepvangers, see "Stylus," "Characteristics of the New 45 RPM Record," Audio Engineering, March 1949, 47; "1960 AES Awards: the Emile Berliner Award," Journal of the Audio Engineering Society 9, no. 1 (January 1961): 72. Snepvangers worked at RCA Victor until at least November 1944: see patent no. 2,426,061. He left Camden because his wife preferred New York: Murlan S. Corrington to the writer, June 6, 1995, p. 1. Wallerstein, in "Creating the LP Record," 57, called Snepvangers "a key factor in the success of our plans."

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design. Columbia's head demanded more from "Goldmark's Folly," and this required skills that Goldmark lacked.[173]

He returned to work on CBS's color television system while Stanton hired an experienced engineer. William S. Bachman came from General Electric, where he had invented the variable reluctance pickup.[174] By September 1947, Bachman's team more than doubled the playing time and developed a tonearm capable of tracing the finer grooves without wearing them too quickly. That winter, Bachman's group attained over twenty-two minutes on a side, enabling the disc to play over ninety percent of all classical performances on two sides. Wallerstein insisted that he be able to hear the scrape of rosin on a violin bow and listen to twenty-eight minutes on a side, the amount necessary to contain any major symphony on four sides. At the same time, aware of RCA's 45 from Snepvangers, Goldmark wanted Columbia to invest in development and production of a 331/3-rpm single.[175]

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[173]Wallerstein, "Creating the LP Record," 58; Stanton OH [part 14], 734-36; Stanton to the writer, August 11, 1997, p. 1; Schicke, 96, 122-23; Goldmark, 133-37; Pierce, "The Phonograph's Forgotten Heros," 46.

[174]"Stylus," "Characteristics of the New 45 RPM Record," Audio Engineering, March 1949, 47; W. S. Bachman, "Phonograph Reproducer Design," AIEE Transactions 65 (March 1946): 159-62.

[175]Schicke, 122; Wallerstein, "Creating the LP Record," 58; Goldmark, 146; Frank Stanton to the writer, August 11, 1997, p. 1; transcription of "National Music Arts Presents: 50th Anniversary of the Long-Play 331/3 Record," National Academy of Sciences, Washington, D. C., January 18, 1998,

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After $250,000, however, Paley put his foot down. Never enthusiastic about capital investment for the sake of manufacturing, he was also dubious about the appeal of the innovation to the small number of record buyers who loved classical music or high fidelity.[176] There might be niche markets, but the single would require new presses, expanded plant to accomodate the transition from 78s, and the confidence that Columbia could lead the pop music industry, where sound quality was of minimal importance, to a new format.

The problem now became those of production and marketing. Hunter adapted part of the Bridgeport factory to cleaner standards than those used to make 78s. Since Columbia did not make phonographs, it licensed Philco to produce a two-speed player. Convinced that Hunt and Pierce would not have the wherewithal to fight Columbia in court, Bachman and Snepvangers designed a pickup based on their patents.[177] As to marketing, Columbia tried to make the LP as similar to 78s as possible, in color and dimensions to ease the transition from one format to a new one.

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p. 2, courtesy of Susan Schmidt Horning, Case Western Reserve University.

[176]Wallerstein, "Creating the LP Record," 58; for more on Paley's resistance to capital investment, see Stanton OH [part 7], 374-77.

[177]Pierce, "The Phonograph's Forgotten Heros," 46. Pierce separates Columbia's offer from the outright theft by other companies in the industry, but I infer that Bachman and Snepvangers used their patents anyway because of their basic nature to microgroove reproduction.

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Vinylite lent itself to coloring. Hunter could have matched the discs to the royal blue label inspired by the use of blue-colored shellac in the Depression. Instead, Columbia retained carbon black as the coloring agent for three reasons. Colored records generated a sense of gimmickry and never sold as well as their black equivalents. After fifty years, record buyers, especially music lovers, associated black with stability and quality. Second, with the higher frequencies recorded on and reproduced from the discs, the graphite particles helped lubricate the grooves. Black discs wore less quickly and played more quietly as a result. There was another practical reason to keeping all discs in a plant the same color. Using dyes meant dedicating a production line because of the cleaning involved before and after a colored plastic; the down-time increased the cost of the records.[178]

Columbia also maintained the same diameters in the LPs as in classical and popular 78s. One team segued together the four-minute high-fidelity recordings onto twelve-inch masters for classical LPs. Others

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[178]Robert Angus, "Why do Records Have to be Black Anyway?" High Fidelity, July 1974, 68. My thanks to Dr. Robert Friedel, University of Maryland, College Park, for recalling a similar article by Angus, "Whatever Happened to Pure Virgin Vinyl? Why Records are Black," Forecast!, February 1975, 60, and to Carlene Stephens, National Museum of American History, for finding this one. Angus's interviewees in the industry responded to the question from a contemporary perspective marked by their efforts to make records during the Arab oil embargo. Polyvinyl acetate, the copolymer in the record compound, also helped reduce groove noise. Because of the difficulty in obtaining it in 1973-74, manufacturers resorted to using more carbon black to compensate: Gene Lees, "The Vinyl Shortage: Does It Mean Poorer and Fewer Records?" High Fidelity, July 1974, 70.

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transferred the eight sides usually available in popular album of ten-inch 78s to ten-inch popular LPs.[179]

Since Columbia did not control the classical market, Stanton arranged a meeting with David Sarnoff to gain support.[180] The two executives lunched together in April 1948. Afterwards, Stanton played an LP in his office through a Harry Olson-designed loudspeaker. Sarnoff became "visibly upset" at the playing time as well as the sound. "I can't believe little Columbia Graphophone invented this without my knowing it," Stanton recalled him exclaiming. Stanton offered to share the technology if CBS could take credit a day ahead of RCA. Sarnoff seemed "genuinely interested" and Stanton arranged a formal demonstration.[181]

Sarnoff and sixteen RCA executives and engineers attended, as did CBS's owner, William S. Paley. After Stanton explained the agreement with Philco, Sarnoff dismissed the subordination of his company. He said that RCA would adhere to Columbia's design if it released a longplaying record.

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[179]Lieberson, "A 33 1/3 Revolution in Recording," 41; William S. Bachman, "From Transcription Disc to LP," High Fidelity, April 1976, 59; Hobson, "The Classic Interview;" transcription of "National Music Arts Presents," pp. 4-5. To be sure, Columbia issued shorter classical pieces on ten-inch LPs, and it and other labels began pressing twelve-inch popular LPs in short order.

[180]Goldmark, 138-40; Schicke, 122-23; Smith, 282.

[181]Smith, 282; Stanton OH [part 14], 737-38; Bachman, "The LP and the Single," 823. Schicke, 119-22, credits Wallerstein rather than Stanton for these negotiations.

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In the meantime, he invited the CBS leaders to a demonstration of RCA's versatility. At the next meeting a week later at Rockefeller Center Sarnoff showed off an RCA longplaying record, a tape recorder, and the 45. He argued vigorously against the introduction of the LP. He took great pride in the changer, "the best in the world, and the quickest," and the "kind of quality that a 7-inch 45 RPM record can produce and does." He also pointed out that the 45 promised to be cheap to produce and distribute.[182]

If this was intended as a threat, Paley and Stanton did not give in. Wallerstein grew anxious over the lack of agreement with RCA and the commitment to Philco. Stanton, desirous of luring Philco's sponsorship from NBC, refused to reconsider the June announcement. There was also the effect of another AFM strike, which held up new recordings all through 1948. Record sales declined that year for the first time since 1937. Debuting longplaying records featuring high-fidelity performances from years before made sense commercially. CBS would gain publicity at RCA's expense, and if the product was as good as promised, then a monopoly would ease the transition from novelty to product. Paley agreed. To defer any longer might

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[182]Schicke, 120-21; Smith, 282; Bachman, 823; Kenneth Bilby, The General: David Sarnoff and the rise of the communications industry (New York; 1986), 262; quotes from Color Television: Testimony of Brig. General David Sarnoff, Chairman of of the Board, Radio Corporation of America, before the Federal Communications Commission, (Washington, D. C., May 3 and 4, 1950), 256, DSL.

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allow Sarnoff to pre-empt their innovation with RCA's system; announcing now pre-empted the pre-emption.[183]

Section X: The Battle of the Formats, 1949-1950

In retrospect, the conflict between the LP and the 45 seems farcical. Of course the 45 was designed for single, mainly popular, performances at home and in the jukebox. By the same token, the LP suited the classical performances for which it was designed as well as collections of shorter pieces of all kinds. Why would either company try to make one size fit all?

The answer extends beyond the engineer's desire for standards or the executive's search for profits, or the record buyer's irritation with the conflict in the first place. Certainly, these had an effect on the outcome. But for RCA, the company with the most at stake in that outcome, the concerns were manifold. Contrary to popular belief, Columbia's early transfers varied widely in sound quality. Doubtless its engineers would improve on that, after which the label would seize the high ground acoustically and culturally. Without staking its claim, RCA Victor threatened to lose not only the classical market but the opportunity to supplant the 78 popular disc with its records and patented changer. Pushing the 45 as a classical format as well not only assuaged Sarnoff's ego but bought the recording department

[183]Schicke, 123; Hobson, "The Classic Interview."

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time to remaster its 78-rpm masters and offer an LP superior to Columbia's.[184]

A. Standing By the 45: Summer 1948

Despite RCA's silence, all was not calm. Should it stand by the 45, improve the 78, or make records the same speed as Columbia's? Over the summer, engineers at Camden, Indianapolis, and the RCA Laboratories in Princeton, New Jersey, argued with Rockefeller Center executives over the proper response. Support for the new speed wavered. Herbert Belar of the Labs' Acoustic Research Group had been charged with record research in conjunction with the Victor division just before Columbia announced the LP. He argued for a microgroove vinyl 78 based on sound quality and compatibility with customers' current collections. Standing by the 78 would leave an impression of conservatism, however, even if one made of vinyl with a microgroove sounded better and played almost as long as the LP. On the other hand, switching to Columbia's speed and standardizing a seven-inch disc with their rival would ease consumer confusion and pave the way for the two-speed players familiar in the commercial sector. By the end of

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[184]In one example of the diffusion of the standard histories into other fields, one business writer used this format battle as an example of a strategy taught at Harvard Business School. Lawrence Shames concluded that after Columbia knocked out the market for 78s with the LP, RCA "ad prac'ed" or overcame the innovation by inventing a record playable only on their turntables. See Shames, The Big Time: The Harvard Business School's Most Successful Class and How It Shaped America (New York: 1986), 36.

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the summer, the "X" record had evolved from "Original" and "Engineering" speeds of 45-rpm to a "Commercial" one of 331/3-rpm.[185]

Either move harmed RCA's reputation for leading-edge innovation. In addition, engineers argued that switching to LP speed for the small disc would result in a record with more distortion than the 45.[186] The ideal response would be to innovate ten- and twelve-inch longplaying 45s as well.[187] More importantly for the Home Instruments Department, even if the company gave up the patents on the record in order to gain acceptance, the changer represented licensing income from the smaller number of turntable manufacturers. In what some saw as the last hurrah of the engineers' influence at RCA, just before Sarnoff turned over the presidency

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[185]For RCA's turnaround at Atlantic City, see Warren Rex Isom, "A Wonderful Invention," (Bloomington, Ind.: videotape produced by RCA Records through Indiana University TV, 1985). Courtesy of Mr. Isom, who rose from sound reproduction engineer to chief engineer of RCA Records between 1944 and 1976. For the other aspects of the debate, see "Disc Reproducer Considerations," June 9, 1948, and the entry for August 31, 1948, in Belar's lab notebook P-4612, Sarnoff Corporation library.

[186]Carson et al., "A Record Changer," 186-87; "Stylus," "Characteristics," 46; Color Television, 257.

[187]The evidence for RCA's flirtation with a large diameter 45 is fragmentary: "Deny RCA Victor Will Manufacture Long-Playing Disc," Retailing Daily, July 7, 1948, 63, repeated July 8, 45; H. Belar, A. R. Morgan, and H. F. Olson, "The Super 45," November 6, 1950, p. 1, Olson Papers, file: "The Super 45," Sarnoff Corporation library; Phil Wooley to the writer, September 11, 1995, p. 2, and October 29, 1995, p. 3. Wooley joined RCA early in 1948 to work on audio in the Home Instruments Department.

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to Frank Folsom, the product groups prevailed, and RCA Victor proceeded with plans to roll out the system.[188]

To some degree they must have been aided by Sarnoff's growing rivalry with William S. Paley, which the business press emphasized in covering the conflict.[189] Born beyond the Russian Pale, trained in the Talmud, and forced to support his mother and siblings as a child , Sarnoff acted on a strong sense of patriarchy in all of his relationships. Paternalism defined his conception of familial, corporate and industrial roles. If the group rallied around the leader who set the standards, all would benefit from ensuing economic success. From this perspective, junior members, in this case Paley and the Columbia Broadcasting System, should not confuse the public with competitive formats in television or records.[190]

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[188]The board of directors elected Folsom president December 3, 1948, to take effect January 1, 1949, on Sarnoff's recommendation: "Changes in RCA Management," Radio Age 9, no. 2 (January 1949): 7.

[189]"RCA Gets Into the Battle of the Discs," Business Week, January 22, 1949, 82-85; "The General's Biggest Battle," Newsweek, December 5, 1949, 62-66; "Business Roundup: Phonograph Record Boom," Fortune, January 1950, 15; Malcolm Forbes, "Fact and Comment: The Bigger They Are--," Forbes, February 15, 1950, 11; RCA's rejoinder, "RCA Officials Hit Back at Forbes Criticism," Forbes, March 15, 1950, 17-18; "At the End of the Rainbow," Time, December 4, 1950, 52; C.B.S. Steals the Show," Fortune, July 1953, in RCA: The Years 1930-1978, 35-40.

[190]While the standard biographers and historians of RCA discuss Sarnoff's background and his ego, none of them links these factors explicitly to his sense of personal and corporate destiny. See Bilby, 3-7, 11-18; Carl Dreher, Sarnoff: An American Success (New York, 1977); Graham, 30-75;

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Production of the 45 players began in the fall of 1948. Even then it is possible Sarnoff would have accepted two new record speeds, one for classical and one for singles, since RCA engineers and marketers had considered the prospect of longplaying specialty disc since World War II. The LPs' sound had been criticized, however, and Paley had begun negotiating with NBC's radio star, Jack Benny. On top of efforts by Peter Goldmark to obstruct RCA's electronic television, this was the last straw. Sarnoff was "deeply affronted" by the successful overtures to Benny, and it was his pique over the betrayal of his RCA family that provoked the battle of the speeds. For a year, RCA Victor would market boxed albums of symphonies in competition with the longplaying records of the rest of the classical industry.[191]

B. Selling and Buying the LP: 1948

Columbia's announcement had mixed effects. The most objective record lovers who attended the press conference thought that Columbia's claims for "'full fidelity' . . . were not borne out. . . . Certainly this was not true when heard through a Philco machine where booming bass, low range

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Lewis, 89-118; Eugene Lyons, David Sarnoff (New York, 1966); Sobel, 42-45.

[191]Bilby, 262-63. It should be noted that NBC had already lured away Ozzie and Harriet and two other programs from CBS: "NBC Moves Ahead of CBS in Fall Program Shuffle," Advertising Age, July 19, 1948, 49. For Sarnoff's opinion, see his testimony in Color Television, and his memo of May 7, 1951, "David Sarnoff Papers," vol. 3, "Color" binder, DSL.

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and cabinet resonance existed." The use of an osmium point on the Philco stylus promised wear of the point and the groove after about sixty plays. The lack of breaks in two concertos played at home was "an interesting experience," but the 78s of the same performances "was more realistic and preferable to our ears." Even allowing for better playback equipment, the writer felt a year was necessary for judgment, especially since Columbia "has developed one of the best records on the domestic market."[192]

Another critic called the LP "the kid-glove record." Engineers expressed similar concerns. Like transcription discs, the LPs were likely to show "a substantial noise level if exposed to wear and dirt" and "should be noisier because of the lower recording level." Another warned of the need to maintain higher production standards because the margin for error was reduced with the finer grooves and slower speed.[193]

As for the market, manufacturers began inquiries almost immediately. Optimists at the National Association of Music Merchants convention held that week agreed that innovation had its best opportunity in a market off fifteen to thirty percent from 1947. Phonograph and record dealers expressed more reservations. Because the two groups did not often

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[192]First and last quotes from [Peter Hugh Reed], "Columbia's Long-Playing Record," ARG, July 1948, 330; middle two quotes from idem, "Editorial Notes," ARG, August 1948, 361; for the osmium stylus, see idem, "Editorial Notes," ARG, December 1948, 97.

[193]Quotes from [Reed], "Editorial Notes," August 1948, 368-9.

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overlap, each wanted to know how the producer of the other component was going to make the system worth the dealer's and customer's investment. At the Home Furnishings Market in Chicago that followed the music convention in July, Philco showed off its two-speed phonographs and claimed that the six-gram pickup was the lightest ever made and offered the widest range of frequency reproduction. The "lack of comment" on the innovation was a "disappointing feature" to the market.[194]

Rumors of RCA's 45 helped defer dealer commitments. The Farnsworth Corporation, which had a cross-licensing agreement with RCA, announced plans to construct a 45-rpm changer, after which RCA, Columbia, Decca, and MGM all denied plans to produce records for that speed. Record dealers also resisted Columbia's efforts to claim that their franchises covered only shellac discs and to enforce quotas of the new records. Without players in people's homes, one dealer asked, "where are we going to dispose of all thses LP's?"[195]

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[194]Frank Stanton to the writer, August 11, 1997, p. 2; "Columbia's Challenge," 82; quotes from "Video Overshadows Radios at Closing Chicago Exhibition," Retailing Daily, July 16, 1948, 19; "Bendix Announces Direct Sales Plan at Furniture Show," Advertising Age, July 12, 1948, 67. Philco's announcement came after one for Congoleum-Nairn's new asphalt linoleum tile. For more on the crystal-based pickup, see "Modern Crystal Phono Pickups," 29.

[195]"Deny RCA Victor Will Manufacture Long-Playing Disc," Retailing Daily, July 7, 1948, 63, repeated July 8, 45; "Phila. Stores Score LP Disc Sales Policy," Retailing Daily, July 21, 1948, 35; "Poll Shows Sharp Contrasts in Long Playing Record Setup," Retailing Daily, July 23, 1948, 19; "New Coercion Charges Hurled in Record Sales controversy," Retailing Daily, July

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Two weeks later, Columbia's agency, McCann-Erickson, unveiled the campaign for the LP. Copy listed the advantages of the discs, including "a tone quality so lifelike you'll scarcely believe you're listening to a record!" The basic message, however, emphasized playing time: a full forty-five minutes. Consumers received "a complete symphony . . . on one record!" High fidelity was of less importance: one observer enthused that the LP was "the answer to the problem of the phonograph fan whose Bing Crosby collection alone spills all over the living room."[196]

For the audiophiles, however, Columbia gained coverage that touted the sound quality of the new records. Audio published information furnished by Goldmark in August and proclaimed that "engineers and music lovers alike are enthused" about the coming LPs.[197] An article in Electronics described the LPs as "transcription recordings for the home," aligning the discs with those used in broadcasting. The author glowed over the 10,000 cps frequency range, the 45 db dynamic range, and the low distortion. In all cases, LPs "outdistance shellac pressings," though Vinylite

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28, 1948, 30.

[196]Ad copy quoted in "Columbia Records Break Campaign for LP Discs," Advertising Age, August 2, 1948, 6; last quote from "Rough Proofs" commentary, Advertising Age, August 9, 1948, 1. For more on the solution to the problem of record storage, see "The Ideal Record Cabinet," ARG, June 1948, 299-301.

[197]C. G. McProud, "Columbia LP Microgroove Records," Audio Engineering, August 1948, 24.

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78s might still remain superior in noise levels.[198] In Radio-Electronics, the writer came to an opposite conclusion based on listening to two LPs, that the "dynamic range is much wider than anything previously heard on records."[199]

Music lovers showed less enthusiasm for the sound even as they embraced the playing time. In the Review, C. G. Burke began a popular series comparing Columbia recordings in their LP and 78 formats. Burke's survey over the course of 1949 included tests for durability and price comparisons based on music per minute, but he focused on the sound.[200]

For dealers, promoting a new format proved a challenge. Aided by Columbia's props, stores put up window displays in which LPs seemed to come off best, despite the lopsided "tombstone" design used on the classical record jackets. LPs offered the basic appeal of "A whole symphony in ONE

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[198][Donald G. Fink], "Transcription Recordings for the Home," Electronics, September 1948, 86-87.

[199]M. Harvey Gernsback, "Microgroove Phonograph Records," Radio-Electronics, October 1948, 30-31; see also John B. Ledbetter, "Microgrooves Mean More Money," Radio & Television News, January 1949, 54-55, 108-10, for the implications for the service industry.

[200]C. G. Burke, "Report on LP: the Question of Wear," SRL, February 26, 1949, 56; Burke changed his mind about the efficacy of osmium points and the durability of microgrooves in "Report on LP: Random Notes," SRL, January 28, 1950, 70. For reader response, see "Letters to the 'Recordings' Editor, SRL, April 30, 1949, 62.

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record!" and "uninterrupted performances."[201] The marketing had its effect. A dealer in New Haven, Connecticut, reported that he sold more LPs than 78s in classical music, which comprised sixty percent of its business.[202]

The mix of formats was of greater import to pop-oriented retailers. Most were upset over the confusion generated among prospective customers, the increased inventory, the price-cutting, and the need for more equipment to play back records in listening booths.[203] The forty-five minute playing time helped confuse customers who heard the rumors about RCA Victor's intentions. Among producers, Sydney Nathan, who turned King Records into the sixth largest label by 1949, had no interest in new speeds or vinyl. Nathan estimated that fifteen percent of the country's phonographs were still springwound. Many of their owners lacked electricity, and some of them preferred their machines' "horrible tone." This was his market for King's lower-class "race" and "hillbilly" records, and he saw no reason for

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[201]"45 RPM Windows, 331/3 RPM Displays," in Harrison (1949), 90-91.

[202]"The New Haven Record Dealer Who Knows How," in Harrison (1949), 41.

[203]"Executive Opinion: 'The Influx of Independents," Business Week, October 15, 1949, 34-35; "Two Sides to Three-Speed Record Mixup," Business Week, April 8, 1950, 80-81; "New Market for New Discs," Business Week, April 8, 1950, 82-83; "Case Report on RCA Victor Records," JWT Archives, 66-67.

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change from the 78 as the pop music format "for years and years to come . . . further than I can anticipate."[204]

C. Responses to the 45: January-September, 1949

While Columbia seemed to move from strength to strength, RCA Victor struggled to organize a counterattack. The Christmas season would have been the best time to start sales, and Victor began remastering 78s and manufactured nearly 400,000 45-rpm players in the fall. Plans to make the records in Camden, however, fell through. The union refused to work with presses that stamped four 45s simultaneously in the time it took to press a 78. RCA moved the operation to Indianapolis where Victor stamped the first 45, "Pee Wee the Piccolo Player," on yellow vinylite, on December 7.[205] Later that month, RCA Victor began showing the system to the label's performers and the leading pop music labels, Decca and Capitol.[206]

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[204]"Executive Opinion," 34.

[205]For phonograph production, see "Historical Files: Firsts: First 45-rpm attachment--production totals," Hagley 2069, box 291. These files have since been reorganized in the Historian's series. "Pee Wee" was a re-issue of a 1947 78 and is displayed at the Thomson History Center, Thomson/RCA Consumer Electronics, Indianapolis. For the four-disc press and union protest, Phil Wooley to the writer, October 29, 1995, p. 2. The move of home instruments to Indiana in response to union demands began in the late 1930s; for more on labor relations in Camden, see Jefferson Cowie, Capital Moves: RCA's 70-Year Quest for Cheap Labor (Ithaca, N.Y.: 1999).

[206]"Record Mixup," Time, December 27, 1948, 52.

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As much as RCA Victor tried to keep the preparations secret, the meetings with Columbia gave its competitor an opportunity for leaks. Canby, writing in the Review, acted as Columbia's stalking horse. To offer a third system threatened "a suicidal chaos of competition" which would provoke "an enormous increment of ill will," implying that Victor already had something to atone for. Kolodin echoed Canby, adding the misinformation that the new record was not microgrooved. After scoring the unnamed label for its "Bourbonish purpose . . . to ignore the lessons of the past," he suggested that the goodwill derived from using 331/3-rpm would "much exceed the selfish pleasure that a battle of annihilation would give to a Pyrrhic victor."[207]

The apocalyptic tone signaled the fear of the music lover over RCA's size and the influence of its philistinism, accentuated by Columbia's self-portrait as the underdog. The music lovers assumed that with enough money, RCA could drive the LP from the marketplace, although the company had not driven another record format from the home since Edison abandoned the cylinder in 1929. The mass media joined in. Newsweek

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[207]Edward Tatnall Canby, "Two Standards—or Three?" SRL, October 31, 1948, ; Irving Kolodin, "," SRL, .

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quoted the critics at length, and Time echoed dealers' fears, and took affront at Sarnoff's truckling to Petrillo in settling the AFM strike in December.[208]

Columbia's source of information about Victor's plans extended beyond the spring demonstrations. On the same day that RCA Victor demonstrated the 45 system to its distributors, Columbia announced it was producing a seven-inch Vinylite 331/3-rpm "LP" with a standard-sized spindle hole. Priced at sixty-three and ninety-five cents for popular and classical performances, respectively, these cost twenty percent less than the equivalent 78s. Columbia also announced that the Mercury Record Corporation would start pressing the larger LPs.[209]

Pre-empted again by Columbia and ignored by the mass media, RCA Victor debuted the 45 for New York distributors and dealers on January 10, 1949, at the Johnny Victor Theater in the RCA Exhibition Hall in Manhattan. Folsom introduced the system as a "healthy ordinary competitive job that people do every day in business." One music lover disagreed with the benefit to the industry as well as the philosophy behind it, mispelling the RCA Victor president's name "Fulsom." Still, he had

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[208] "New Record Scramble?" Newsweek, November 8, 1948, 85-86; "Record Mixup," Time, December 27, 1948, 52; "One for Harry," Time, December 27, 1948, 56. For more on Time's anti-union stance, see the cover story on Petrillo, "The Pied Piper of Chi," Time, January 26, 1948, 18-22.

[209] "RCA Victor, Columbia Wage Battle Over New-Type, Long-Playing Discs," newspaper clipping of United Press story, January 10, 1949, courtesy Claudia Depkin, BMG Entertainment Archives, New York; "Out of the Groove," 82-84.

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thought little of the LP's sound at Columbia's announcement and was impressed by Victor's staging. Engineers hooked up a 45 changer to a Berkshire phonograph to stake claim to clean reproduction up to 15,000 cps.[210]

The industry response to the 45 was not encouraging. Record and phonograph sales dropped forty percent in 1948 from the year before of the AFM strike and the rising demand for television. Not all producers embraced the LP as a stimulus, but Columbia sold $5,000,000 worth of the format in four months, double what it expected. The music lover who praised the sound wished "more than ever" for standardization in the recording industry. High fidelity or not, the addition of a third speed, as one radio executive noted, was invitation to the chaos that the railroad industry would suffer from a change in track gauge.[211]

James Murray defended Victor's innovation in The Saturday Review's "Recordings" section. In an ingenuous essay, he argued that RCA's unilateral effort at standardization served the public interest more than Columbia's. The company had tried longplaying records before and seen them fail in the marketplace. Without specifying what made the 45 the leading edge of the phonograph system, Murray asserted that the

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[210][Peter Hugh Reed], "Recording--Quo Vadis?" ARG, January 1949, 130, 134-35.

[211]Ibid., 130; "Record Mixup," 52.

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"distortion-free, noise-free performance" of the record "opens the way for . . . home instruments of wider frequency range and truer fidelity." Murray ignored his audience and emphasized Victor's interest in "satisfying the largest segment of the public which constitutes the . . . market for records."[212]

The music lovers rejected his logic. Victor's 1931 innovation had only playing speed in common with Columbia's LP. Editor Irving Kolodin countered that the choice of standards was one of diameter--the 45's 67/8 inches--versus playing speed. Why tie classical performances to Victor's procrustean bed of five minutes when Columbia's system allowed labels to use "as much of a record's surface as their needs require"? To support his reasoning, Kolodin printed six letters also rebutting Murray's explanation and noted that none of the many other correspondents supported RCA Victor's innovation. Writers to The American Record Guide expressed similar irritation.[213]

For records, Victor started with four singles, including the Boston Pops Orchestra's rendition of "Gaité Parisienne" and Arthur Crudup's "That's All Right." A series of singles and albums followed as recording

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[212]James W. Murray, "Standardization and RCA," SRL, January 29, 1949, 49-50.

[213]Irving Kolodin, "Impressions," and "Letters to the RECORDINGS Editor," SRL, January 29, 1949, 47, 66; [Peter Hugh Reed], "New Pathes in Recording," ARG, February 1949, 162.

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engineers remastered 78s from the MALB catalog.[214] The term "album," which had lost its literal meaning with the debut of the LP, suffered further in the case of the 45. These were now stored inside a box thick enough to gave sufficient room to label the edge with half-inch print.

Somewhat to his surprise, Kolodin found himself congratulating Victor's engineers on the quality of their transfers. The 45s' surfaces were "uncommonly quiet," more so than LPs, if prone to warpage, and "the smoothness and response fo the Red Seals are outstanding." Like the LPs, the sound correlated to the original recordings. Having played the discs on an adapted player, the "Recordings" editor reserved judgment on the changer and its effect on appreciating the twelve sides of Tchaikovsky's "Sleeping Beauty."[215]

Burke took up the issue four months later. He refused to compare 45s to the LP, except in the issue of continuity. Compared to Victor's 78s, the 45s excelled "in tonal quality" but the relative newness of the standard releases reduced the difference shown up between the LP and 78s. Otherwise "the Victor novelty consists of an obsolete principle (short duration) complicated by defective mechanical application." Carson's efforts to save on material left insufficient margin for production flaws, and Victor recommended

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[214]Boston Pops on RCA Victor 49-0100; Crudup on 50-0000. My thanks to Claudia Depkin, BMG archivist, for providing the release information.

[215]Irving Kolodin, "45 RPM--First Phase," SRL, March 26, 1949, 56.

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masking tape on the labels to keep the discs from slipping when stacked under the pickup on the turntable.

Technically, the discs received high marks. An anonymous engineer in Audio Engineering began the review process with information from RCA licensees and other record companies.[216] "Stylus" described the 45 as "a more compact, lower-cost record of higher quality . . . . aimed chiefly at the popular market--which includes 80% of all disc sales." After praising the changer, he tackled the issue of sound quality when compared to Columbia's single. Other factors being equal, the 45's higher speed enabled a wider frequency range and much less tracing distortion as the needle approached the center.[217]

Stylus refused to compare the 45 with the twelve-inch LP because of their different markets and prices. When pressed, he showed no love for music lovers. Classical records were "a mere excrescence, a wart on the surface of the record field. . . . Is there any reason why 80% of the market should take inferior engineering to please 20%?" Another article by the

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[216]A less well-informed article endorsing the 45 is Tom Gootée, "The 'New Look' in Popular Records," Radio & Television News, March 1949, 41, 96-97.

[217]"Stylus," "Characteristics of the New 45 RPM Record," 6. Given his pseudonym and familiarity with both companies' technology, Stylus might have been W. H. Rose of Frank L. Capps and Company, which manufactured styli for the recording industry. Before World War II, Rose lunched occasionally with friends from NBC's Recording Division and Columbia Records: Robert J. Callen, "Hollywood Sapphire Group," Audio Engineering, January 1948, 17.

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writer reinforced this point by showing how 331/3-rpm recording also contributed to degraded high-end response. When all was said and done, however, Stylus echoed the opinion of Belar and Olson's lab. Why not produce a longplaying 78? With a groove pitch similar to the LP and 45, companies could put nineteen minutes on one side of a twelve-inch 78, where the "quality of the sound would be superior to that on the LP at the same diameter."[218]

The battle among the inventors settled down to distortion. Just how much better were the new discs to their counterparts or the 78? Carson, Burt, and Reiskind highlighted the challenge of avoiding more than ten-percent intermodulation distortion. Roys had established that as the level noticeable by most listeners, and it became a sales point for the "live-talent tone" in ad copy. Al Pulley, Victor's senior recording engineer, gave a three-hour demonstration to the Record Guide's Peter Hugh Reed, who noted the improvement over 78s within the player's limited frequency range as well as the potential with a wide-range reproducer.[219] By comparison, Goldmark, Snepvangers, and Bachman withdrew their professional article

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[218]First quote from "Letters: Comment on Comments," Audio Engineering, May 1949, 4, 41, in response to "Comments on 45 Report," Leonard Carduner to the editor, Audio Engineering, May 1949, 4; second quote from "Stylus," "Characteristics of the New 45 RPM Record," 47; recording study in "Stylus," "The Cutting Sylus [sic] Problem in Microgroove Recording," Audio Enginneering, April 1949, 26-28.

[219][Peter Hugh Reed], "Preamble On the New Records: Editorial Notes," ARG, March 1949, 194.

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on the LP when they learned of the specifications for the 45. Unable to dispute the problems of inner-groove distortion of any kind, they resorted to highlighting the superiority of the LP's sound compared to the worst levels of harmonic distortion produced on a 78.[220]

The arguments among the pure engineers missed the point, however. Canby was not alone in stating that, aside from the many other ills that beset the LP, Columbia's invention attained a higher aesthetic fidelity by reducing the number of unintended breaks in a performance. This improvement contributed to a higher technical fidelity. The LP experience took "recorded music right out of its own field, into the 'actual performance' feeling of a radio or a live concert." Nearly fifty years into the habit, listeners found that those "familiar disturbances . . . suddenly turn out to have been of vital psychological significance." Continuity overwhelmed ticks and pops, wow, the delicacy of the grooves, and the IMD on the inner grooves of the discs. In these conclusions, musically inclined audiophiles

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[220]Peter C. Goldmark, René Snepvangers, and William S. Bachman, "The Columbia Long-Playing Microgroove Recording System," PIRE 37, no. 8 (August 1949): 923; Charles Hobbs to the writer, June 29, 1996, p. 1, and August 12, 1996, p. 5.

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and music lovers alike agreed.[221]

D. Marketing the 45: March-September 1949

All of this added to the problems of marketing the 45. J. Walter Thompson's staff became increasingly frustrated over the budgetary and philosophical limitations to its role. They pointed to the fifty percent of consumers who did not own phonographs and the few record purchases of those who did as indicators of an untapped market. RCA Victor should help dealers by pushing a new audience to their stores. The ascendance of Folsom, who was fully confident of his own marketing expertise, and the persistence of traditional methods of retailing records aggravated conflicts with the agency. The unexpected death in 1950 of vice-president John Williams, who supported Thompson's approach, contributed to the agency's loss of influence.[222]

While Victor's new president must have shared Thompson's belief in marketing to the consumer, Folsom had his own ideas about the method.

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[221]Edward Tatnall Canby, "Record Revue," Audio Engineering, March 1949, 30; see also "Letters: LP Reactions, Richard H. Dorf to the editor, Audio Engineering, April 1949, 6, 46; [Peter Hugh Reed], "Recording--Quo Vadis?" ARG, January 1949, 130; "The Three Types of Phonograph Records--Which to Buy?" Consumers' Research Bulletin, November 1949, 17. The writer of the latter article was a professional engineer who also taught music.

[222]Joseph G. Wilson, RCA Victor executive vice-president, died in June 1950: "Buck, Elliott Inherit Most of Big Job at RCA Victor Left by Death of Wilson," Billboard, June 24, 1950, 4; "Case Report on RCA Victor Records," JWT Archives, 61-65.

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He summed this up in the "Folsom Formula." All advertising promoted the trademark, and the quality and advantages of Victor's products. The emphasis on value reflected Folsom's Catholicism, his upbringing in the far west early in the century, and his sales experiences during the 1930s.[223] It is difficult to argue with Folsom's success, but his approach limited an agency's role in associating desire for a product with other experiences or encouraging consumption for its own sake.

Victor's Record and Home Instrument Department executives seemed to share neither Thompson's philosophy nor methods. They had tradition on their side. No more than fifty percent of American households had ever owned a phonograph. Radio surpassed phonographs in household diffusion during the Depression, and television would do so by 1953.[224] In the phonograph industry, distribution and sales traditions were not that far removed from the Victrola era. Dealers no longer sold talking machines door to door, but the devices remained an item for the young,

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[223]Hartwell, "The Man Who Sells," 101-102; "Case Report on RCA Victor Records," 76, formula reproduced as Exhibit I, 107. Of Folsom, the anonymous agency historian wrote, "It is not the job of a Case Report to dip into psychoanalysis, but it is no secret that Folsom was hard to get along with": 50.

[224]Calculated from Sterling and Haight, Tables 100-B, 650-B, and 660-B on pp. 4, 357, and 363 respectively.

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bought primarily in the months before Christmas.[225] Victor's research and development notwithstanding, self-service record shopping had not yet come into its own. Consumers still bought most records through independent dealers who offered playing booths to sample the music and sound before purchase. The bulk, cost, and risk of records limited any one store's inventory.[226]

The 45 system went on sale in New York City on March 31, 1949, supported by the area's largest distributor, Bruno, which was owned by David Sarnoff's brother Irving. In a low-cost campaign, RCA then sent teams of salesmen to its other distribution centers across the country. RCA's control of its distributors and their supply of televisions forced dealers to add the new phonograph system to their stock. It was a cheap and easy

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[225]In 1960, dealers made forty percent of their phonograph sales in the fourth quarter and twenty percent in the thirty days before Christmas: "RCA-General," February 8, 1961, part (4), in JWT Archives, Review Board box 25, folder: "Meetings: RCA Corporation General Summaries, 1961-1966," Hartman Center. These percentages do not differ significantly from those in 1920.

[226]Paula Dranov, Inside the Music Publishing Industry, (White Plains, NY: 1980), Figure 6.1, "Record Distribution in the 1930s to early 1940s," 112; The Editors, "Opportunities! . . . in Record Shops," Forbes, August 1, 1947, 18. See also the articles on record store design and display and the relationship to self-service in [Neil F. Harrison, ed.], Record Retailing Yearbook (New York: 1948 ed.), especially "The Blueprint for Tomorrow's Record Store Puts Customer Convenience and Comfort First, 44-48; "The 'Shop of Tomorrow'--Streamlined, Purposeful Elegance," 53-54; and Raymond L. Green, "Singles, Self-Service Style, Make Their Sales Soar," 57-58.

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alternative to Thompson's ambitions, for it passed on the problem of inventory even as it hurt dealer relations.[227]

How, then, was a dealer to lure prospects to hear and hear about the first new record since Victor's longplaying and picture discs in the Depression? Unlike the Orthophonic system's debut, the 45 had no player capable of demonstrating a clear advantage in sound over the best 78s. A rival innovation that offered a unique advantage already existed and enjoyed support by other companies.

The answer was novelty in appearance, to provoke curiousity and desire. Dealers' windows for 45s had no slogan. They promoted a system, reminded the consumer of the need for a new player, and featured rings of colored vinyl discs. The first 45s appeared in colors chosen by industrial designer John Vassos as "characteristic of seven classifications of music": black for popular, red for classical, yellow for children's, pink for folk, green for country western, blue for "semi-classical," and light blue for "international." Victor touted the colors for adding "eye appeal to ear

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[227]Mike Ranalli to the writer, April 10, 1995, pp. 1-2. Ranalli was in charge of the 45's sales program for the Home Instruments Department. Similar pressure explained successful sales of RCA radios during 1948's slump: "R.C.A.'s Television," Fortune, September 1948, in RCA: The Years 1930-1978, 31.

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appeal in the playing of recorded music" and easing sorting by dealer and consumer.[228]

The campaign became a nightmare for Victor and its dealers over the summer. The records in the windows sometimes suffered from the sun's heat. Worse, the colors reinforced the impression of artifice and cheapness that plastic represented to most consumers. The colors also bogged down production by complicating the changeover from one record to another in the Indianapolis plant.[229] RCA engineers and advertising claimed that the changer, the basis of the innovation, was the fastest ever, although reviews suggested otherwise.[230] Pricing also ran against acceptance of the new speed.

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[228]Ranalli to the writer, p. 3; [Reed], "Preamble on the New Records," 193; "45 RPM Windows, 331/3 RPM Displays," 90-91; Jack M. Williams, "45 RPM--An Adventure in Unique Merchandising for the Imaginative Dealer," and quotes from John D. Benedito, "What Plastics Mean to the Recording Industry," both in Harrison (1949): 16-17 and 25 respectively; see ads reproduced in "Case Report on RCA Victor Records," JWT Archives, after p. 63.

[229]Warren Rex Isom, "Record Materials Part II: Evolution of the Disc Talking Machine," IAES 25, no. 10/11 (October/November 1977), 722. The only people I have met who recalled the 45s' debut clearly also recalled the impression of cheapness: Robert Heinz to the writer, April 10, 1998, and Charles Rhodes to the writer, January 7, 2000. See Jeffrey Meikle, American Plastic: A Cultural History (New Brunswick, N.J.: 1995), for the best explanation of the place of plastic in American culture.

[230]The issue was confused first by the distinction between the time of the changer's operation and the time from music on disc to music on the next. RCA also simplified the changer mechanism in 1950, which had an eight-second cycle compared to five for the original model. This itself indicated the reduced priority of changeover time once RCA Victor began issuing LPs, as well as the challenge of calibrating the changer in mass

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The changer and phonograph retailed for $24.95 and $39.95, respectively, or more than equivalent 78 or LP players. The records saved storage space but, at 95¢ for Red Seals and 65¢ for everything else, only the premium discs represented a significant discount from 78s. Finally, after maestro Arturo Toscanini agreed to pose for a series of photographs while listening to the "jewel-box" phonograph, Victor never used those photos.[231]

At the same time, Columbia pressed its advantage in providing "uninterrupted music at its finest."[232] In June, it began promoting a record player for $9.95. By July, Wallerstein reported that Americans had bought 750,000 LP players and three million LPs.[233] Dealers cut 78 prices in half, and estimated in one case that Columbia's LPs were outselling Victor's albums of

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production. See Carson et al., "A Record Changer," 174, 179; "New RCA-Victor '45's'--results of CU's first listening tests," Consumer Reports, May 1949, 197; "Comments on 45 Report," 4; "Stylus," "Comment on Comments," 4, 41; "The Three Types of Phonograph Records--Which to Buy?" Consumers' Research Bulletin, November 1949, 17; Goldmark, 142-3. In 1931, the Electromatic and Electra record changers had change specifications of five and seven seconds respectively: Irby, "Developments," 586.

[231]Toscanini Legacy, folder M56 B-2, New York Public Library for the Performing Art--Music Division, New York City. Despite the use of the Legacy's database, I could find no reference to Toscanini's opinion of the 45.

[232]See the happy couple enjoying Edward R. Murrow's "I Can Hear It Now," vol. II, in the full-page ad in Life, January 23, 1950, 5.

[233]"Record Dither," Time, September 5, 1949, 52; Edward Wallerstein, "A Review of Columbia's New Long Playing LP Microgroove Records," in Harrison, (1949): 15.

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45s by a ratio of 30:1. While Victor promoted Vaughn Monroe's "Riders in the Sky," the bestselling pop song in the spring of 1949, its failure to exploit the popularity of Broadway musicals haunted them. Columbia issued the soundtrack to South Pacific on LP at the same time, sales of which assured other labels that the format appealed beyond the classical market. By September, Decca and London, along with fifteen classical labels, had joined Mercury in pressing LPs of popular and classical content. Only Capitol joined RCA in making 45s while it also pressed LPs. When the convention of music merchants met in July, Columbia's sales manager gave a talk over the background of an LP side of Tchaikovsky's "Nutcracker" suite. The effect was impressive, and in a straw poll of speeds, dealers voted overwhelmingly for the LP system.[234]

E. Consumer Choices, 1949

For the consumer, the situation was more complicated. Should she--for Victor's advertising featured women and their hands holding the delicate discs almost exclusively--buy one system and stop listening to the other label's performers? Should he buy both and "clutter up his living room [and] his record cabinets," or stand pat and stick to 78s? In the fall of 1949, one consumer group's engineer evaluated the three speeds and five formats: shellac 78s, Vinylite 78s, 331/3 LPs, 331/3 singles, and 45s. He had

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[234]"Record Dither," 52; "The General's Biggest Battle," Newsweek, December 5, 1949, 62; Wallerstein, "Creating the LP," 61.

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little good to say about either new speed. The LP emitted "a peculiar 'spitting' type of distortion which is objectionable to the musical ear." Most pressings were poorly centered, resulting in "excessive 'wow'" while the "clicks and pops" generated by an LP's surface were "more disturbing than a low-level steady hiss" given off by a 78. The 45, "with economic factors duly considered . . . is a good idea" and provided less distorted reproduction. But the cleanliness of the recording made the surface noise and motor rumble more obvious. The cheapness of the phonograph and the limited frequency reproduction--70 to 4,000 cps--made Victor's choice of a new speed especially puzzling. When one considered all eleven factors involving cost, sound, repertoire, durability, standing pat appeared to be the best bet. The engineer suggested, however, that newcomers buy into the 45 if they were "not primarily interested in the highest grade of reproduction. . . . For serious music lovers" a 331/3-rpm record-playing attachment would take care of the occasional LP.[235]

By May 1949, when Columbia had been selling LPs for nearly a year and RCA Victor the 45 for six weeks, dealers outside New York City reported that the new records comprised only fifteen percent of sales.[236] The variety

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[235]"Fight Between the Record Makers--the innocent customer takes a beating," Changing Times: The Kiplinger Magazine, August 1949, 39; "The Three Types of Phonograph Records," 15-19, quotes from 18, 19.

[236]"Fight Between the Record Makers," 39.

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of formats left record sales floundering, but we should not ascribe the decline in sales entirely to indecision over record speeds. The AFM strike in 1948 and a national recession in 1949 held up sales, first in records, and then across the economy.[237] In the home entertainment sector, television set sales accelerated from one to three million in those two years, and would continue to siphon off consumers' disposable income. Finally, the major labels' control of the popular music industry itself fell in a slump between the end of the big bands and the rise of rock 'n' roll. From 1948 to 1952, Victor had only six of the forty-eight top-selling discs, compared to thirteen in the previous three years. Columbia and Victor both cut prices on 78s in 1949 and started or revived discount label that summer. Record sales did not recover 1947 levels until 1955.[238] The irony was that records as a medium for music slumped just as popular interest in music swelled. Spurred by an industry push for music education, an amusements tax that reduced the number of dance halls after the war, and the increase in

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[237]In 1949, consumers' disposable income declined .2% in constant dollars: Sterling and Haight, Table 300-C, 114. See also "Business Roundup: 1949 in Retrospect," Fortune, January 1950, 11.

[238]Anderson et al., "Hit Record Trends," Table 1, 33; "Columbia Seen Cutting Retail Price to 60¢, Setting Trend," Variety, March 23, 1949, 37; "CRC Into 49¢ (inc. tax) Disks via Harmony Label," Variety, June 8, 1949, 45; "RCA 50%-Off Clicks Big, But Also Helps Other Regular-price Sales," Variety, June 16, 1949, 39; "RCA Decides on 49¢ Price for Cheaper Label; Revive Bluebird Tag," Variety, July 6, 1949, 39; Traiman, "The Record Industry," 786, but see Sterling and Haight for industry sales in constant dollars, Table 350-A, 190, and Table 650-B, 357, for the decline in sales volume of phonographs.

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broadcast and recorded music, instrument sales and interest in music boomed in the late 1940s.[239]

Marketing the 45: September-December 1949

Sales of 45s went from bad to worse over the summer. Victor's share of the record market fell from twenty-one percent in 1948 to well under fifteen percent in 1949. RCA Victor and Columbia's executives met to find a compromise. Columbia held the upper hand: by September, Victor was the only major label not making LPs while only Capitol joined in pressing 45s. The ten- and twelve-inch records were used for both the prestigious classical performances as well as popular albums. In such a situation, agreeing with Columbia that both labels would press both 45 and 331/3 rpm records seemed the only way out.[240]

J. Walter Thompson and the Home Instruments Department disagreed. Since 45s could be adapted to small spindles, phonograph manufacturers would make only small-spindle changers, obviating the need for the 45 system and the 45. The company would lose its reputation

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[239]"It's Music, Music, Music," Business Week, July 22, 1950, 32. See also the rise in number of entries related to music, as well as phonographs, in the Readers' Guide to Periodical Literature; and The Music Index 1949: Annual Cumulation, (Detroit: 1949). Florence Kretzschmar began The Index in January 1949, citing "revolutionary developments in television, microgroove recording, and electronics" as stimulating "new audiences and a greatly increased public interest" (1). The annual volumes jumped in size from 308 to 505 pages in two years.

[240]"Case Report on RCA Victor Records," JWT Archives, 56-58.

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completely unless RCA went all-out to convince the industry, dealers, and consumers that its system "was here to stay."[241]

The decision to follow Thompson's advice probably involved Sarnoff as well as Folsom. In the context of corporate pride, RCA's imminent involvement in government hearings over the future of color television, the patents on Carson's changer, and the inherent advantages of the 45 over popular 78s, RCA renewed its investment in its system. Over the twelve months from September, Thompson and RCA embarked on a marketing campaign that demonstrated the "effectiveness of hard selling in this type of situation."[242] Over the last three months of the year, dealers sold 45 changers at an annual rate of 1,500,000 per year, while sales of the records rose faster than those for 78s or LPs. For the new year, Victor dropped the price of the player and phonograph to $12.95 and $29.95, while it installed the changer in a set of consoles and combinations that, at the top of the line, included television, AM and FM radio, and a changer for the other speeds.[243]

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[241]Ibid., 57, 60-61.

[242]Ibid., 57.

[243]"The Public Has Chosen 45," (RCA Victor: 1950), Hagley 2069, Historian's series II, box 3, folder 5: "Mixed Product - Trade Catalogs and Instruction Manuals, 1928-1950."

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The label also began recording performances for its own longplaying records. Its classical performers had watched their royalty income shrink and as their contracts came up for renewal, they demanded a Victor LP. Victor's leadership agreed, but extracted endorsements of the 45 in return. In the one advertisement placed in The Review, none of the artists declaiming on the fidelity of the 45 were featured in the albums listed for sale.[244]

Section XI: Accepting the Inevitable: RCA Victor's Longplaying Record, January 1950

With the momentum of the Christmas season sales and the prospect of continued heavy marketing, RCA Victor and its customers assured the future of the 45. On January 4, 1950, RCA Victor announced the imminent arrival of its own longplaying disc. In a full-page ad in the Review's "Recordings" section, the "pioneer and world leader in recorded music" announced a new policy over Frank Folsom's signature. In the future the "World's Greatest Artists and Music" would appear on "ALL phonograph

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[244]Michael Gray, "Record Reissues--An American Perspective; An Interview with John Pfeiffer, RCA Records," ARSC Journal 8, no. 2/3 (1976), 6; "Jack Pfeiffer's Corner: The Audio Interview," p. 2, http://www.classicrecs.com/jackint2.htm, visited February 17, 1999; "Case Report on RCA Victor Records," JWT Archives, 59-60; "The World's Greatest Artists Applaud RCA Victor's 45 rpm System," full-page advertisement in SRL, October 29, 1949, 49; see also the ad proofs in the RCA Victor advertising collection, Camden County Historical Society, Camden, New Jersey.

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speeds!" The copy still focused on the 45, which was "here to stay and is destined to lead all other types of recorded music." In a bid for the heartstrings of older music lovers, RCA Victor restored the "Victrola" trademark in a line of home entertainment consoles that could play all three speeds. The label also promised to issue all new releases on 78 "as long as there is a demand for them." Finally, "to serve those music lovers who wish play certain classical selections on long-playing records," Victor would begin offering "a new and improved" record using "an exclusive RCA Victor processing method which ensures high quality and tonal fidelity."[245]

The music lovers and the industry applauded the move. Irving Kolodin noted with satisfaction that he had given Victor one year to realize that the "smaller if more discriminating" segment of consumers would not accept the 45 for classical performances.[246] Still, with a new administration at RCA Victor making every effort to mollify the music lovers, Kolodin found himself praising the label's LPs as "better than I remembered them from 78 listening."[247] C. G. Burke thought it "not improbable that Victor,

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[245]Full-page ad, "RCA Victor Announces . . . ," SRL, January 28, 1950, 65, which repeated the message of a booklet, "Facts About Records," (RCA Victor: c. 1950), courtesy Claudia Depkin, BMG Entertainment Archives.

[246]Irving Kolodin, "Impressions," SRL, January 28, 1950, 55.

[247]Quote from [Irving Kolodin], "RCA Goes to LP," SRL, February 25, 1950, 60.

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which fewer discs substandard technically than any other company," would immediately produce LPs of high quality. The reviews that followed the first releases in April justified his prediction and ensured the LP's status as a vehicle for high culture and high fidelity.[248]

[248]Quote from C. G. Burke, "Report on LP: Random Notes," SRL, January 28, 1950, 70; idem, "78-45=33," SRL, April 29, 1950, 58-59.

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Conclusion

By the end of 1950, producers and consumers had fixed the LP and 45 in their respective niches. LPs comprised forty percent of the album market and fifty-seven percent of classical sales. By the fifth anniversary of the LP, 150 labels produced records in the format, compared to ten or twelve in 1948, and Columbia claimed it sold twenty million LPs in that time.[1]

The 45 made up only eighteen percent of album sales and fourteen percent of singles in 1950.[2] When RCA finished spending $5,000,000 on "hard selling" in 1952, however, the 45 was equally established in the children's and pop markets; it passed the 78 in unit sales two years later.[3] Other companies took up the 45--Columbia being last to do so--or promoted changers for the three speeds and others that labels might see fit to introduce

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[1]"LP's Fifth," Newsweek, September 7, 1953, 82-83.

[2]"Case Report on RCA Victor Records," pp. 64-65, J. Walter Thompson Archives, Account Files, box 16, folder: RCA Account History, c. 1953, John W. Hartman Center for Sales, Advertising, and Marketing History Special Collections Library, Duke University, Durham, North Carolina.

[3]Roland Gelatt, The Fabulous Phonograph: From Edison to Stereo, rev. ed. (New York: 1967), 296; Russell Sanjek, American Popular Music and its Business: the First Four Hundred Years, vol. III: From 1900 to 1984 (New York: 1988), 246, accepts a report that the phonograph industry sold 6,000,000 "kiddie players" in 1952 alone.

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in the future.[4] RCA Victor abandoned the 45's claims to superior fidelity when it introduced the 45-rpm "EP" disc in 1952. These discs carried two songs on each side. By extending the playing time toward the label, engineers obtained seven minutes and fifteen seconds of music, the intermodulation distortion being of a level "adequate for this type of program material."[5] Other, smaller labels, decided some consumers would exchange the increased distortion for popular selections from classical performances, and pressed their EPs on red plastic in imitation of Victor's red seal label.[6]

Even as inventors, entrepreneurs, and consumers assigned the record a material fixity, they continued to improve the capacity of the LP for more sound, to profit from record sales, and develop listening cultures that diffused to the larger public. Similar prices and competitive performance

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[4]"All Record Phonograph," Radio & Television News, May 1949, 94; "V-M Corp. Launching Advertising Campaign on Its Tri-O-Matic Record Changer Line," Radio and Television Weekly, January 10, 1951, 8; full-page ad for Zenith Cobramatic, in Life, December 4, 1950, 6; "Zenith Introduces Zenith Cobra-matic," RTW, January 17, 1951, 13.

[5]Benjamin Carson, Alexander Burt, and Hillel Reiskind, "A Record Changer and Record of Complementary Design" RCA Review 10, no. 2 (June 1949), 188.

[6] See, for example, Royale extended play 45 r.p.m. EP 194, Ludwig von Beethoven, Egmont Overture/Leonore Overture, National Opera Orchestra, and Parade extended play 45 r.p.m. EP 9033, Bizet's Prelude to Act 1" from Carmen/ "La Kermess" from Gounod's Faust, State Opera Company, both in the writer's possession.

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for the two labels drove Columbia's and RCA Victor's engineers to make further production improvements. These included heated styli for cutting smoother master discs and variable groove-width recording that extended the frequency and dynamic ranges of records. In 1952 members of the newly formed Recording Industry Association of America established a single standard for recording and reproduction characteristics, based on RCA Victor's research. This represented the equivalent of forming interchangeable parts for the sound of records and phonographs. It helped ensure that consumers received the same emphasis of bass and treble from different records on one phonograph, or the same record on different phonographs. At the same time, standardization encouraged engineers to manipulate the sound of the recording space and the placement of microphones in order to obtain a richer aural experience.

The reductions in production, distribution, and retail costs; the return of radio stations to music broadcasting and the use of television and movies to promote pop stars; the fusion of regional and ethnic musics into rock and roll; and the increase in production capacity fuelled new sales highs.[7] While the large labels continued to dominate the industry, the lack of patents, the

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[7]Robert A. Mittelstaedt and Robert E. Stassen, "Structural Changes in the Phonograph Record Industry and Its Channels of Distribution," Journal of Macromarketing, Spring 1994, 31-44; Philip H. Ennis, in The Seventh Stream: The Emergence of RocknRoll in American Popular Music (Hanover, N.H.: 1992), 133, called the 45-rpm player "probably the single most important piece of technology facilitating rock's appearance."

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importance of perceptiveness in musical tastes, and the low barriers to entry brought on by excess manufacturing capacity all encouraged the growth of small labels catering to niche audiences.[8]

Among these trends was another one: the diffusion of the concept and culture of high fidelity. A court case that permitted retail record discounts accentuated the pressure on non-price advantages, even as high fidelity consumers gained an eponymous magazine, a professional society, and a mass market in home entertainment consoles.[9] Even as the LP ascended as a standard of high fidelity, people applied the term to other experiences, starting when Philco needed a new sales pitch for its televisions.[10] In 1957 the nuns and students of Holy Family College in Philadelphia named their basketball team the Hi-Fis to symbolize the

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[8]Richard A. Peterson David G. Berger, "Cycles in Symbol Production: The Case of Popular Music," in Simon Frith and Andrew Goodwin, eds., On Record: Rock, Pop and the Written Word (New York: 1990, 147.

[9]Christopher Sterling and Timothy R. Haight, The Mass Media: Aspen Institute Guide to Communication Industry Trends (New York: 1978), Table 350-A, 190; Russell Sanjek, American Popular Music and Its Business: The First Four Hundred Years, vol. III from 1900 to 1984, (New York: 1988), 238, 243. See also Robert P. Dupin, "The Non-Price Competition in the Phonograph Record Industry at the Manufacturers' Level," (M.B.A. thesis, University of Pennsylvania: 1957), and Algin Braddy King, "The Marketing of Phonograph Records in the United States: An Industry Study," (Ph.D. diss., The Ohio State University, 1966).

[10]"Noted With Interest: High Fidelity Television," High Fidelity, September-October 1952, 86.

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college's modernity.[11] Console phonographs became known as "hi-fi's" and "stereos," thereby associating the equipment with the sensation. By the end of the century, the term had moved well beyond the world of sound reproduction. Writers employed the term to describe the precision of programmable "brilliant munitions" and the quality of computer-simulated nuclear explosions.[12]

Columbia's introduction of the LP, and RCA's response, marked the conclusion of the material development of Edison's phonograph record. The fact that the perpetual runner-up to Victor--Columbia--innovated the landmark disc for high-fidelity confirms that there is nothing simple about the process of technological evolution. RCA Victor's experience with the 45 testifies to the fact that people do not innovate revolutionary change in a vacuum, that innovations can be ahead, behind, or right on time for popular acceptance. The direction of the record's evolution depended as much on timing and the people supporting other technologies and practices as it did on the predilections and patents of its backers, the limits and

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[11]Peggy Sexton, "Holy Family Records Another 'First' with Organization of Varsity Team," The Tri-Lite (Philadelphia: Holy Family College), March 29, 1957, p. 4. When the college added a men's team in 1987, it changed the nickname to "Tigers." My thanks to Gail Farr, Holy Family College archivist, for tracking down this reference.

[12]"'Ultra Computer' Sets Major Speed Milestone," Lockheed Martin Today 3, no. 3 (March 1997), 5; Don Atkins and George Crawford, "Reprogramming Brilliant Weapons: A New Role for MASINT," American Intelligence Journal 17, no. 3-4, (1997), 45. My thanks to Eric Freiwald for providing, unintentionally, the latter reference.

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capabilities of the technology at any moment, and the desire for profit. To say that these groups improved the record for technical, market, or cultural reasons begs questions of intention: which improvement, which market, which sales approach?

The records' construction by pure plastics, microgrooves, and mathematics gave them capacities of sound reproduction that participants exploited for another fifty years while developing better recording and reproduction systems. The advantages for all involved by 1950--in expense, suppleness, bulk, playing time, fidelity, scale of recorded ensembles, and number of companies offering records--were immense in comparison to those in 1925, 1900, or 1889.

Given the continuing interest in the possibilities of the technology for technological, commercial, and cultural reasons, the improvement of the record was inevitable. It was determined, however, only by the participants' contingent and unpredictable cooperation in shaping the record and its sound to their mutual satisfaction. In the form of the LP, the record stopped acting as a bottleneck to high fidelity and became the leading edge by which inventors and consumers measured the rest of the system and its contributions to sound reproduction. From the mid 1950s to the early 1960s, music lovers enjoyed a "golden age" in sound quality to which audiophiles and music lovers harken back and for which major labels remaster compact

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discs today.[13] Was it actually a golden age? Did the LP sound that much better than classical recordings before or since?

Such assertions imply a classical ahistoricity about which historians are understandably wary. This study indicates that in the evolution of a technology, there are moments where the participants and their definitions of improvement converge. In this respect, the construction of a golden age in technological accomplishment is no different than the construction of cultural excellence in theater or opera. The early 1890s and late 1920s rival the 1950s as periods where inventors, entrepreneurs, and consumers found a commonality of interests, just as the early 1900s and the 1930s indicate historical moments where the interests of participants diverged.

Given their coincidence with radical innovations resolving a presumptive anomaly in sound reproduction, acceptance of the notion of technological improvement helps reinforce a distinction between normal and revolutionary change. The very reluctance regarding notions of historical progress should also militate against resistance to claims that the best sounding phonograph records appeared some forty years ago.

Consider the fortunes of the record since the 1950s. A brief review supports the argument that changing interests of participants in the

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[13]See, for example, a pair of articles by Michael Gray on "The Winged Champion: Mercury Records and the Birth of High Fidelity," The Absolute Sound nos. 60-61 (July/August and September/October 1989), 47-57 and 46-57 respectively.

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technology has taken the record, and the quality of sound reproduction, in unexpected directions by unexpected means. It also suggests that as in the past, the leading edge of the technology continues to offer ever better sound reproduction

Given their profits in the late 1950s, large producers were disinclined to make another major innovation in the record. The ones that followed, stereophonic and quadraphonic sound on records, ultimately succeeded in the first instance because the inventors agreed on an international standard before production, and foundered in the second because of an international format battle among engineers and producers and the recession of the early 1970s.[14] The timing and nature of stereo's introduction was akin to that for the LP. Their engineers having agreed on a standard for two-channel discs in the winter of 1957-58, the major companies sat on the innovation. In March 1958 a small company issued a stereophonic disc and another provided a stereo pickup cartridge and stylus to play the record. The audiophile press promptly publicized these innovations. To maintain its reputation for audio leadership in the eyes and ears of the mass consumer, RCA Victor and the other large companies started issuing stereo discs.

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[14]H. E. Roys, "The Coming of Stereo," Journal of the Audio Engineering Society 25, no. 10/11 (October/November 1977), 824-7; idem, "Reminiscing--The Stereophonic Record," Journal of the Acoustical Society of America 77, no. 4 (April 1985), 1332-34; J. G. Woodward, "Quadraphony--A Review," idem, 844, 848.

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Consumers generally forsook the purchase of stereo equipment in favor of color television. They also ignored RCA Victor's stereo cassette system, introduced at the same time. For five years, as engineers struggled to correct the distortions generated between the stylus and the stereo groove, music lovers and audiophiles sustained stereo as a niche market or novelty. It offered a dimensional sense of sound reproduction that reinforced the quality of classical recordings, and it offered unusual sensory experiences when used with "ping-pong" music rebounding between the speakers.

When the broader consumer market bought into stereo in the late 1960s, Japanese and American manufacturers tried and failed to persuade that group to commit to quadraphonic records and four-speaker reproduction. Meanwhile, inventors and entrepreneurs developed and promoted magnetic-tape cartridges for non-household applications. European engineers reduced RCA's cassette to its present size in the early 1960s, and RCA collaborated with three other companies on the eight-track cartridge used in automobiles at the same time.[15] Eldridge Johnson would have understood the twenty-plus years of "hard pounding" required to improve the sound, production, distribution, and cost of magnetic formats until consumers embraced them as the record of choice in the late 1970s.

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[15]Oscar P. Kusisto, "Magnetic Tape Recording: Reels, Cassettes, or Cartridges?" JAES 25, no. 10/11 (October/November 1977), 829-33; Sterling and Haight, table 350-B, 191.

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Despite their commercial success, pre-recorded magnetic media never overcame the LP's reputation for high fidelity. Consumers valued the new formats more for their portability in vehicles and on people than for the quality of sound. Static notwithstanding, records retained their high-fidelity reputation because there was no better medium. At RCA Victor, the recognition of the value of the trademark in avoiding price competition ensured that the label would not compromise the sound quality.[16]

During the 1970s, however, changes in RCA's corporate accounting that turned each factory into a profit center, the struggle with the rising cost of vinyl because of the Arab oil embargo, and the challenges of mastering new digital recording techniques all contributed to a decline in the quality of reproduced sound. The experiences of a generation of consumers with noisy LPs may have contributed in the 1980s to their embrace of compact discs (CDs), one of whose advantages lay in the virtual absence of surface noise.

Inventors, entrepreneurs, and select groups of consumers have sustained the analog format by returning it to niche markets and novelty status. The LP survives in used record stores where original pressings of RCA Victor's "Living Stereo" and Mercury's Olympian "Living Presence"

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[16]See the following articles in RCA Engineer 3, no. 2 (October/November 1957): A[braham] M. Max, "Record Stamper Manufacture," 14-17; G.[eorge] P. Humfeld, "The Story of Plastics in Record Manufacture," 18-23; S. D. Ransburg, "Molding Phonograph Records," 23-25. These are reprinted in "Record Engineering at RCA," (RCA: 1957).

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albums retail to the collectors market at prices ranging up to five hundred dollars.[17] While major labels remaster and re-release records from the "golden age" on compact discs (CDs), smaller companies seek out the best master stampers to repress Victor's records on high-quality vinyl. Their supporters claim that these repressings surpass the originals in sound quality because of the selections involved, the limited production runs, and the quality of the vinyl compound.

The popular music consumer did not ignore the fortunes of the LP despite the industry's attempt to abandon the format in 1990. A youthful revolt against digital culture in the rock music industry resulted in a revival, and many performers have their records pressed in limited runs on LP as well as CD. Record albums now often contain two discs with fewer songs per side. This permits an increase the amplitude of the groove and a boost in the dynamic range to a level approaching that possible on the CD. Smaller, regional independent labels continue to release seven-inch records in an array of colors, although many of these play back at 331/3-rpm and some have reduced the spindle hole to the diameter established by Eldridge Johnson a hundred years ago.

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[17]The Princeton Record Exchange was selling a copy of Ottorino Respighi's Pines of Rome/Fountains of Rome, Fritz Reiner and the Chicago Symphony, RCA Victor LSC-2436 (1960), for $599.99 on April 20, 2000. Most Living Stereo records were listed for between $20.00 and $80.00, and some could be had for under $10.00. The monophonic "shady dog" labelled records of the 1950s have lost their allure: several were availble for a dollar each in the floor bins.

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In the last two years of the 1990s, corporate and grass-roots innovations such as the minidisc and MP3 format on the Internet have gained followings. These digital technologies use data-compression techniques that degrade the sound quality from that possible on a CD. The innate appeal of MP3, in which consumers trade sound quality for free copies of songs, suggests that the LP may last even longer as an example of accomplishment in sound reproduction.

When Edison invented the phonograph record, he also invented something less tangible: reproduced sound. Whether or not one has instruments by which to measure it, defining the shape and sound of phonograph records remains a subjective experience. This has never stopped people, however, from making the record a part of our constructed environment and arriving periodically on a collective judgment on its qualities. The triumph of the LP as the vehicle for high fidelity experience, and the term itself as a metaphor for an artificial reality, reinforce the point of how much of sound reproduction and other sensory experiences are socially constructed and adapted to circumstances, depending on the interaction of inventor, entrepreneur, and consumer.

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Reference Materials

A Note on Sources

One of the challenges to research on the recording industry is locating archival and industrial sources. The General Electric Company bought RCA in 1986, disposed of its corporate archives in New York, and sold off or closed various branches of the corporation in the next two to three years. Fortunately, several historically minded individuals at RCA--Frida Schubert in New York, Alice Archer and M. Phyllis Smith in Princeton, Frederick O. Barnum, III, in Camden, and Frank McCann in Indianapolis--rescued parts of RCA's legacy. These collections, consisting of various technical files, researchers' papers and notebooks, photographs, internal serial publications, and historical files in the public relations departments, are now available with various levels of finding aids or inventories. It is difficult to describe the latter collections especially, but they include a grab-bag of interviews, correspondence, memoirs, and promotional materials. The Hagley Museum and Library provides research grants; the curator of the David Sarnoff Library is working on organizing the collections there and at the Sarnoff Corporation Library; and access to the Thomson/RCA Library in Indianapolis requires recognition that multinational corporations usually have higher priorities than enabling historians to do research on company time. The BMG Entertainment Archives in New York City contains primarily recording date data and is similarly difficult to visit.

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The Library of American Broadcasting offers corporate papers from an NBC vice-president, a unique run of the RCA Victor serial Scanner, and oral histories in the Broadcast Pioneers Library. The Columbia University Oral History Research Office is completing processing of a massive series of interviews with Dr. Frank Stanton, president of CBS during the competition with RCA in the 1940s. The NBC Papers at the State Historical Society of Wisconsin contained several files of interest. The opening of the J. Walter Thompson Archives at Duke University's John W. Hartman Center offered wonderful agency case histories on the RCA and RCA Victor accounts and considerable insight on the prickly nature of agency-client relationships. For advertising scholars, the Camden County Historical Society complements this collection, as it acquired the RCA advertising collection from the Camden plant as well as a substantial run of Voice of the Victor. The Camden Public Library apparently has vertical files on Victor Talking Machine Company and RCA. When the city repairs the crack in the wall of the building, they will be available again. Owen D. Young's papers at St. Lawrence University provided the perspective from the RCA president's office during the 1920s on the negotiations to electrify the phonograph industry and on acquisition of the Victor Talking Machine Company.

A brief visit to the AT&T Archives opened files on the making and marketing of electrical recording to the phonograph industry, as well as Emile Berliner's ongoing relationship after he sold the company his patent

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for the carbon button microphone. David Sarnoff culled his papers of almost any reference to his management of RCA as president between 1930 and 1949, but his public pronouncements and the odd memo, when cross-referenced with documents at the other repositories, confirm his commitment to innovation. The Rockefeller Archives contained far less on RCA than I anticipated, while the Toscanini Collection at the New York Public Library, Performing Arts section, may warrant a closer examination. There is a finding aid database at the library. Joanne Barry is working on the retrieval of the Philadelphia Orchestra Association Archives and the Ochestra's participation in the Bell Laboratories' high fidelity research of the early 1930s. The National Archives contained files from the War Production Board on shellac restrictions during World War II

The use of court records and patent suits is less useful after the acoustic era, as there were far fewer disputes. An attempt to check patent case files for the 45-rpm record changer was cut short; the only RCA Victor litigation at the Mid-Atlantic branch of the National Archives in Philadelphia refers to a labor dispute.

For the acoustic era, I relied on the years of research by Raymond R. Wile of Queens College, who spent over twenty years vacationing with his family near archival repositories to write the narrative of the recording industry in the nineteenth century. I consulted, too briefly, Eldridge R. Johnson's papers as photocopied from the originals at the American

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Historical Center in Laramie, Wyoming. These are available by appointment at the Eldridge R. Johnson Victrola Museum in Dover, Delaware.

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Manuscript Collections

AT&T Archives, Warren, New Jersey
- Arnold Record Group
- Charlesworth Record Group
- Colpitts Record Group
- Microfiche Files

BMG Entertainment Archives, New York City

Camden County Historical Society, Camden, New Jersey
- RCA Advertising Collection

David Sarnoff Library, Princeton, New Jersey
- David Sarnoff Papers
- RCA: Annual Reports and Proceedings of the Stockholders Meetings
- RCA Public Relations Historical Files
- David Sarnoff Research Center Public Relations Historical Files
- RCA Corporate Public Relations Historical Files
- Radio Age/Electronic Age

Eldridge Reeves Johnson Victrola Museum, Dover, Delaware
- Eldridge R. Johnson Papers

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Files of Nicholas F. Pensiero, 1904-1984, Collection #2138

Radio Corporation of America, Collection #2069
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- Camden Engineering Memoranda
- RCA Victor Technical Reports
- Photograph Collection

John W. Hartman Center for Sales, Advertising, and Marketing History

Special Collections Library, Duke University, Durham, North Carolina
- J. Walter Thompson Company Archives
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Rockefeller Archives, Valhalla, New York
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NBC Papers

Thomson/RCA History Center, Indianapolis, Indiana
Historical Files

Office of the Clerk, U.S. Court of Appeals For the Federal Circuit, Washington, D.C.
U.S. Court of Customs and Patent Appeals

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Chemical Heritage Foundation, Philadelphia, Pennsylvania

Free Library of Philadelphia: Main and Tacony Branches

Holy Family College Library

LaSalle University Connelly Library

Library of Congress
- Performing Arts Reading Room
  - The Phonograph Monthly Review
- American Memory website:

Princeton University
- Engineering Library
- Firestone Library
- Music Library

Univerity of Maryland, College Park
- Engineering and Physics Library
- Hornbake Library
- Music Library
- McKeldin Library

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